THE STORY OF OUR FLAG.

[*All the flags mentioned can easily be made with a little ingenuity, and the piece should not be given without them.*]

[A company of 14,—7 boys and 7 girls,—march across the stage, singing the chorus, "*Rally Round the Flag.*" Each boy carries a furled flag, and one of the girls, who marches near the centre, carries an American flag unfurled. They form in line, front face, and the girl who carries the American flag steps two paces in advance of the line and raises the flag.]

All, in Concert:—

"Up with our banner bright,
Sprinkled with starry light,
Spread its fair emblems from mountain to shore,
While through the sounding sky
Loud rings the nation's cry—
Union and Liberty! One evermore!"

Leader.—We honor our country's flag that tells us of glorious deeds and of great hopes. This flag that waves over every state in our Union; this flag that is saluted at every rising and setting sun in every fort or camp of the United States; this flag that protects the black and the white, the rich and the poor alike; "the flag with a star for every state and with all the stars for all the states"; this grand Flag of our Union which our soldiers have named "Old Glory,"—we honor it and salute it.

All in Concert:—

"Thousands have died for it, millions defend it,
Emblem of justice and mercy to all."

Leader.—Let us tell the story of our flag.

First Girl.—In the early days of the colonies before they united for the Revolution, the rattlesnake was used at the head of the newspapers of the day. It was represented as cut into thirteen parts with the motto, "Join or Die."

Second Girl.—After the Union of the colonies this device was changed to a snake coiled and ready to strike, and, still later, this representation was placed on the flags with the motto, "Don't tread on me."

Third Girl.—Was this the flag that waved over the breastworks at Bunker Hill?

First Boy.—No; I have the honor of showing you *that* flag. Here it is. [*Unfurls flag.*] It is blue and has the red cross of St. George upon a white field with a pine tree in the upper right hand quarter of the cross.

Second Boy.—The first war vessels that were commissioned by Washington carried a flag called the Pine tree flag. This originated with the Massachusetts colony. I show you that flag. [*Unfurling.*] You see that it is a green pine tree on a white ground, and on this side [*turning it*] it bears the motto, "APPEAL TO HEAVEN."

Fourth Girl.—The English papers of that day describe a flag like this, taken from a colonial vessel in 1776, and a similar one is shown on a map of Boston published in Paris that same year.

Third Boy.—It is said that the "Alfred" carried this flag and another with thirteen stripes in red and white, but with no stars. On the stripes was a coiled rattlesnake with the motto, "DON'T TREAD ON ME." This is the Rattlesnake flag, which I now show to you. [*Unfurling it.*]

Fourth Boy.—The Culpepper men carried a different one yet. Here it is. [*Unfurling it.*] You see this is a white flag with a coiled snake and the motto, "DON'T TREAD ON ME." In addition, it bears Patrick Henry's words, "Liberty or Death."

Fifth Boy.—The flag that I carry was used by some of the South Carolina regiments in the early part of the Revolution. It is the Palmetto flag [*unfurls it*], a white ground bearing the green palmetto tree.

Fifth Girl.—Yes, and South Carolina is still associated with that emblem, for you see it on her State Coat of Arms.

Sixth Girl.—There is another flag that we want to see. When the British evacuated Boston, March 17, 1776, what flag did our men carry then?

Sixth Boy.—This is it [*unfurling it*]. It has the thirteen stripes of red and white, but no stars. In their place, it has the red cross of St. George, which is a perpendicular bar crossed by a horizontal one, and the white cross of St. Andrew which is in the form of the letter X.

First Girl.—That flag was first unfurled on New Year's Day, 1776, over the camp at Cambridge where Washington was in command.

Second Girl.—It was not until after the Declaration of Independence was made that it was decided to have a national flag.

Seventh Boy.—On June 17, 1777, Congress voted that the flag of the thirteen

United States should be composed of thirteen stripes, alternate red and white, and a Union of blue with thirteen stars. This is the flag [*unfurling it*].

Second Girl.—The stars here are arranged in a circle, and this was the first Star Spangled Banner.

All sing "Star Spangled Banner." (*For words and music see pages 4 and 5*).

First Boy.—This flag was first used at Saratoga in October, 1777, when Burgoyne surrendered his army to General Gates. We can easily imagine with what feelings of pride the soldiers turned to it as it led to such a victory.

Second Boy.—The first sailor to raise this flag on an American war ship was Capt. John Paul Jones. It is said that he took a small boat and sailed up and down the Schuylkill River with this flag flying, to show it to the people.

Fourth Girl.—Yes, and we are specially interested in this, for it is said that this flag was made and presented to him by the ladies of Philadelphia.

All, in Concert:—

"And is the old flag flying still,
That o'er our Fathers flew,
With bands of white and rosy light,
And field of starry blue?"

Fifth Girl.—It was the original design to add a stripe as well as a star for each state in the Union, and this was done when Vermont was admitted in 1791 and Kentucky in 1792.

Sixth Girl.—The flag remained with fifteen stripes and fifteen stars until 1818; by that time more new states had been admitted, but the extra stripes and stars had not been added.

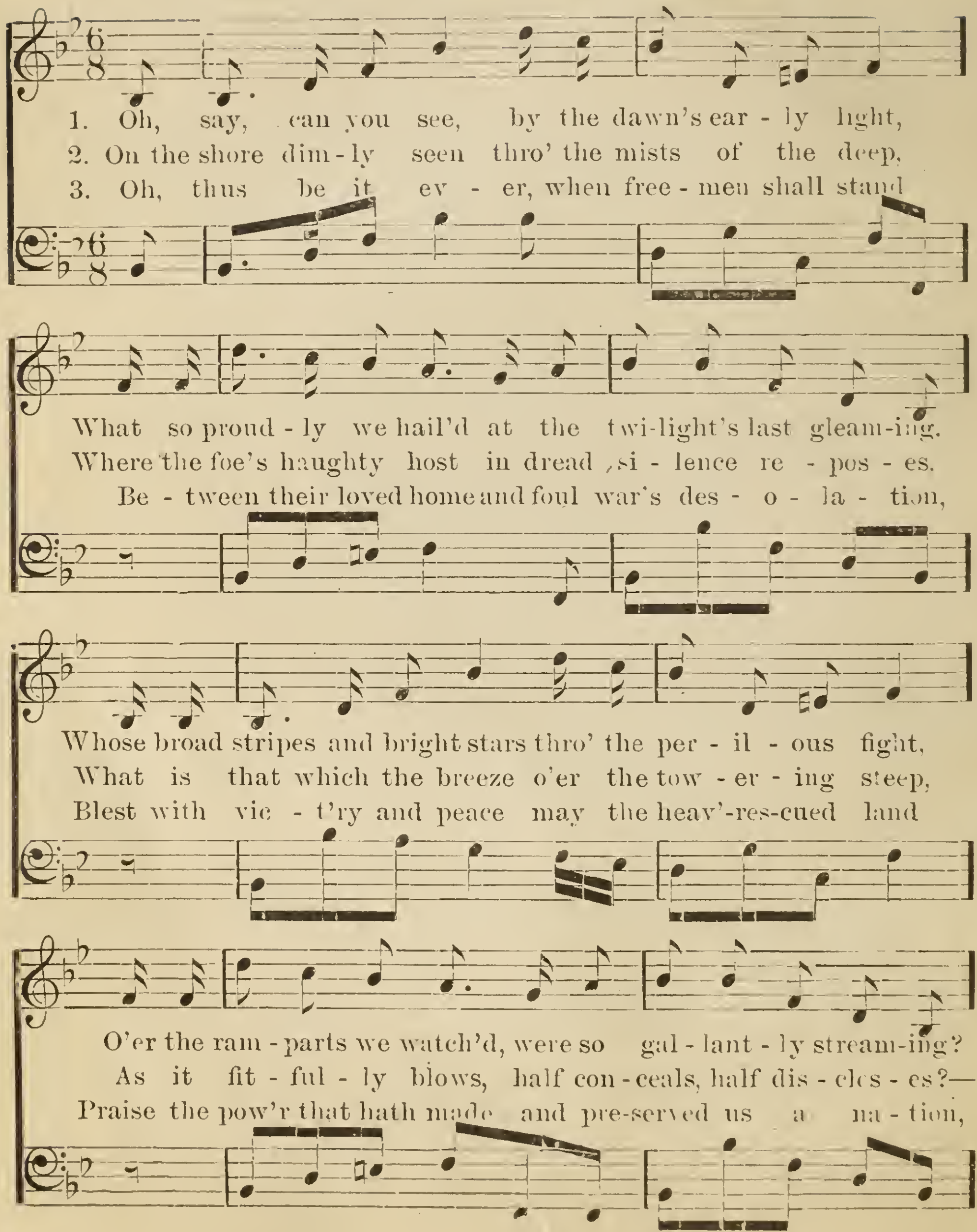
Third Boy.—In 1818 it was decided to return to the thirteen stripes, thus keeping ever in mind the original thirteen states that gained us a nationality, and to represent the new states by added stars. That year we see twenty-one stars in the blue Union.

Leader.—How many stars are there in the blue Union now?

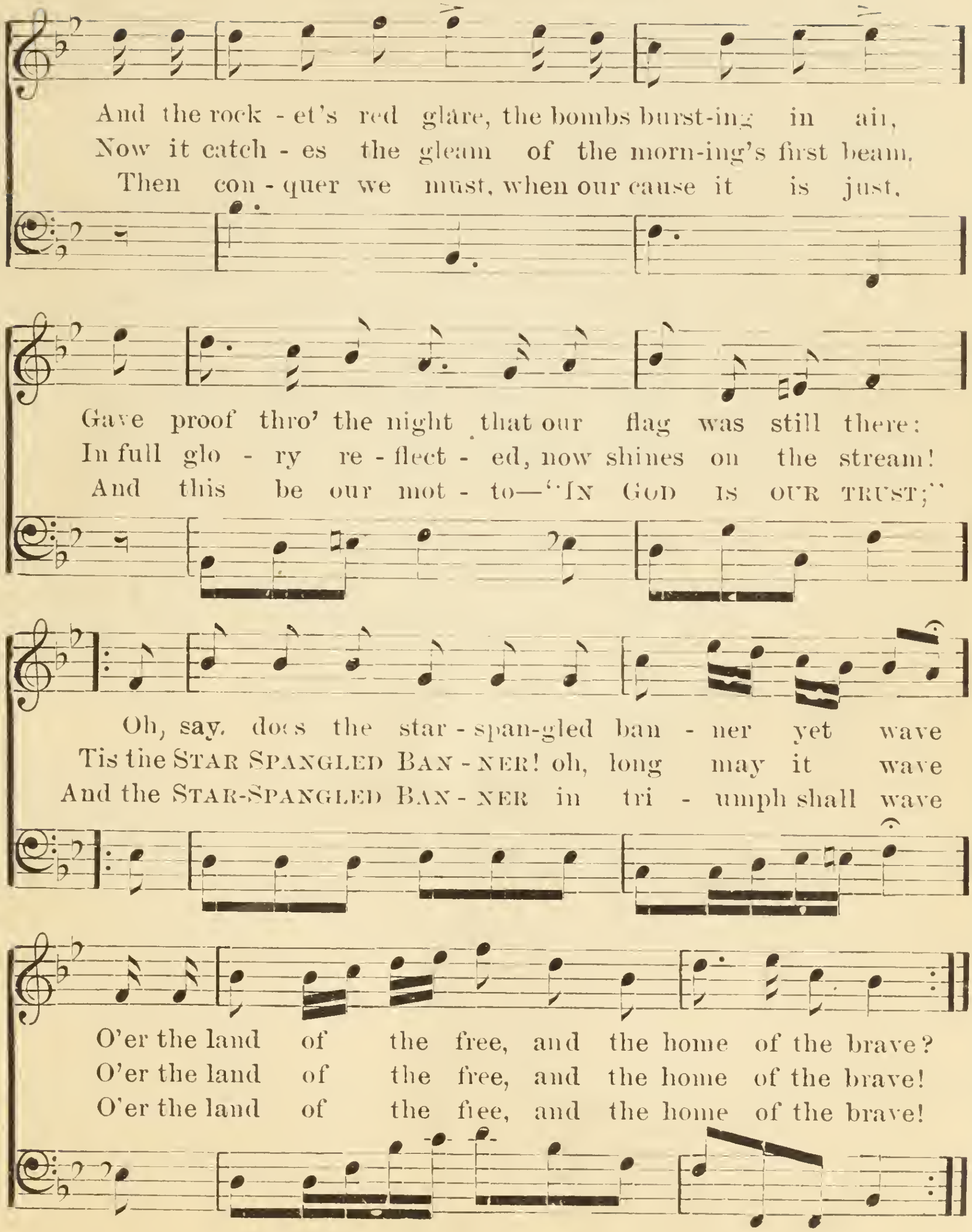
Sixth Girl.—There are forty-five; and

Though many and bright are the stars that appear
In that flag by our country unfurled,
Their light is unsullied as those in the sky;
And they are linked in the truest and loftiest tie
In their motto of—"Many in one."

THE STAR-SPANGLED BANNER.



THE STAR-SPANGLED BANNER.



Fourth Boy.—As we have unfurled the different flags let us remember the times that they represent, and notice the growth and changes which at last gave us our own Red, White, and Blue.

All sing chorus of "Red, White, and Blue."

Fifth Boy.—Let us remember, too, what it has cost our fathers in these later years to keep this flag "with not a stripe erased or polluted, not a star obscured," but bearing that sentiment dear to every American heart, "Liberty and Union, now and forever, one and inseparable."

Sixth Boy.—Many a veteran's heart fills with pride as he sees this old flag flying and recalls to mind the Grand Army of the Republic that carried it on to victory.

Seventh Boy.—"Beautiful as a flower to those who love it, terrible as a meteor to those who hate it, our flag is the emblem of the power, and the glory, and the honor of seventy millions of Americans."

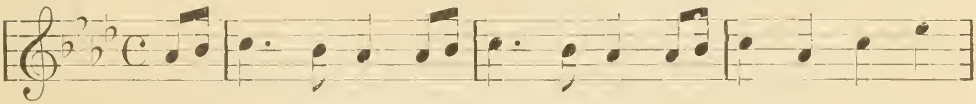
All, in Concert:—

"Fling abroad our starry banner
  To the pure, fresh northern blast,
Sanctified by present glory
  And the memory of the past!
Beat our drums beneath its waving,
  Blow our bugles loud and clear,
And the brave, inspiring music
  Let mankind's enslavers hear!"

[All sing the first verse of "*Our Flag is there,*" while standing in line, then march off, singing the second verse.]

OUR FLAG IS THERE.

This song was written by an officer of the American Navy during the war of 1812.



1. Our flag is there! Our flag is there! We'll hail it with three
2. That flag withstood the bat-tle's roar, With foemen stout, with

loud huz-zahs! Our flag 'is there! Our flag is there! Be -
foe-men brave; Strong hands have sought that flag to low'r, And

hold the glo-rious stripes and stars! Stout hearts have fought for
found a speed-y wa - t'ry grave! That flag is known on

that bright flag, Strong hands sustained it mast head high, And
ev - 'ry shore, The stand-ard of a gal - lant band, A -

Oh! to see how proud it waves, Brings tears of joy in ev - 'ry eye.
like unstain'd in peace or war, It floats o'er freedom's happy land.

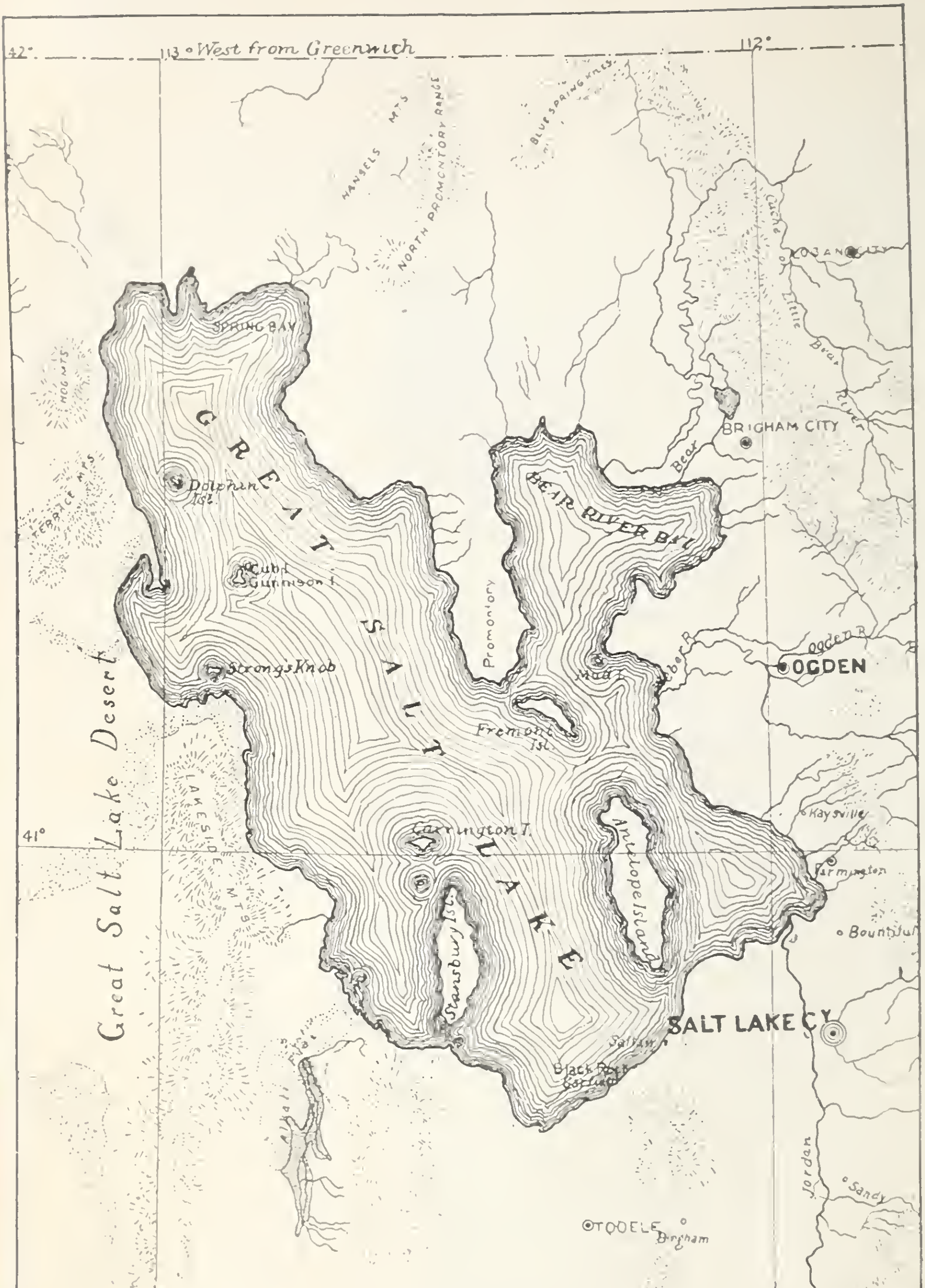
THE

GREAT SALT LAKE

PRESENT AND PAST.

Photograph by Savage.

I. Black Rock; south end of Great Salt Lake. (Oregon Short Line Ry.)

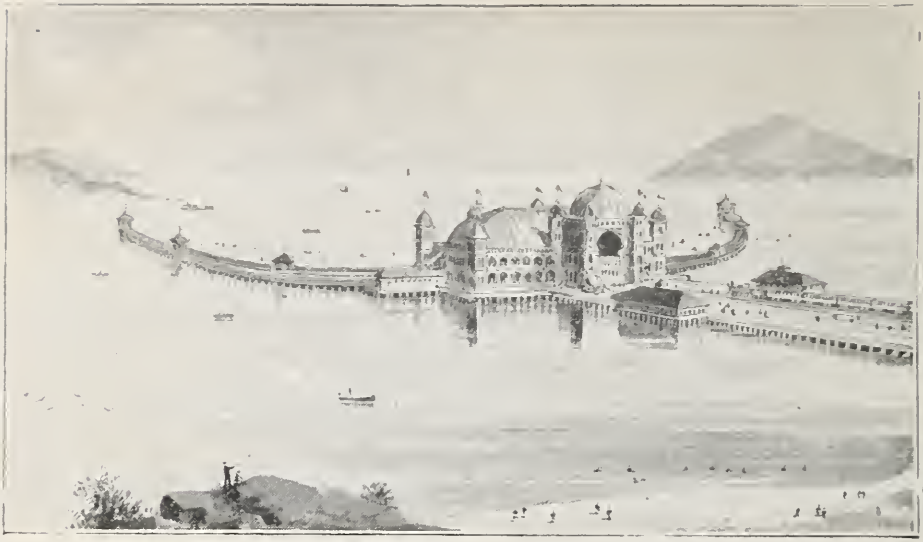


II. Map of the Great Salt Lake.

III. Flock of Young Pelicans, Hat Island.

IV. Gulls on Hat Island.

Photograph by Johnson.



V. Saltair Pavilion: bird's-eye view.

VI. Side View of Saltair Pavilion. (Salt Lake and Los Angeles Railway.)

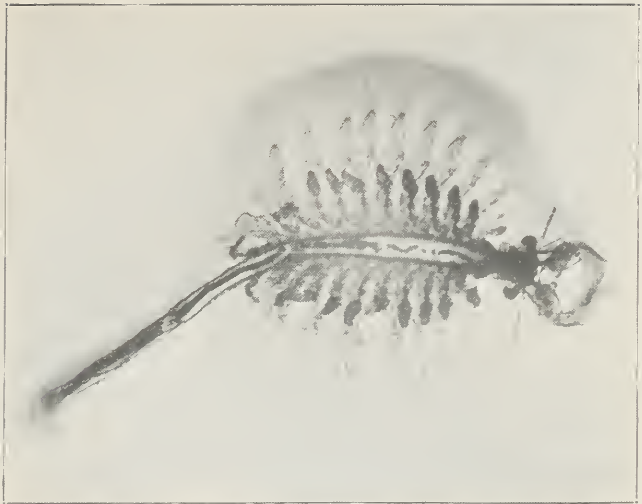
VII. Central Pavilion, Saltair. (Reached by Salt Lake and Los Angeles Railway.)

VIII. Garfield Pavilion; from the shore. (Reached by Oregon Short Line Railway.)

IX. Garfield Pavilion: from the water. Old sea-cliffs on shore. (Oregon Short Line Railway.)
Photograph by Savage.

X. Inland Crystal Salt Co.'s Works. (Salt Lake and Los Angeles Railway.)

XI. Coarse Salt. Inland Crystal Salt Co.'s Ponds.
(On line of Salt Lake and Los Angeles Railway.)



XII.

XIII.

Brine Shrimp, *Artemia fertilis* (Verril): or *Artemia gracilis;* from the Great Salt Lake. XII, male: XIII, female.

From photomicrographs by J. E. Talmage.

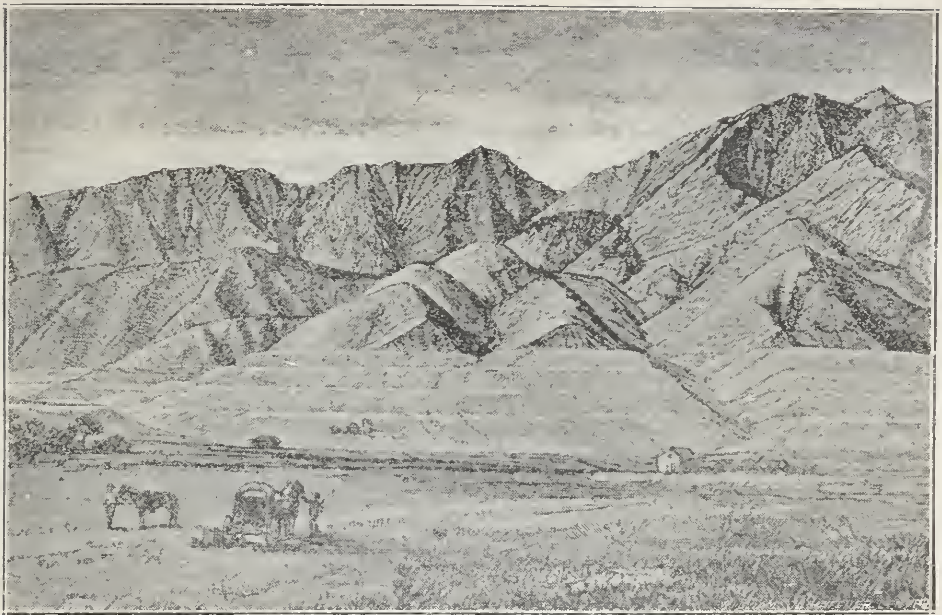
XIV. Map of the Great Basin and its Lakes.

Copied from U. S. G. S., Monograph I: Plate II.

XV. Map of Lake Bonneville.
Copied from Gilbert's map; U. S. G. S., Monograph I.

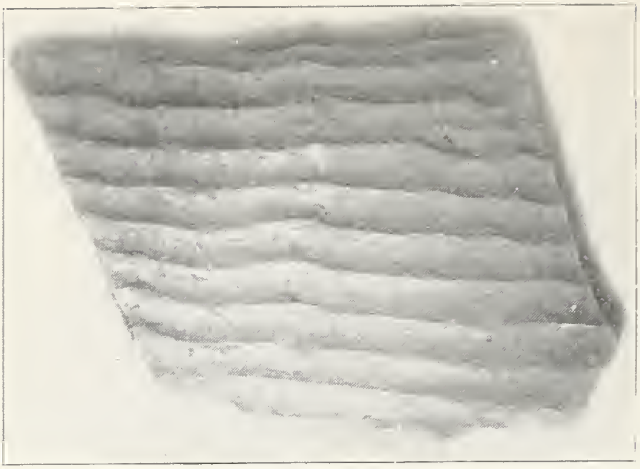
XVI. Shore Lines on Oquirrh Mountains, West Salt Lake Valley.

XVII. Shore Lines of Lake Bonneville: north end of Oquirrh Mountains. After sketch by Holmes (U. S. G. S., Monograph 1: Plate I.)



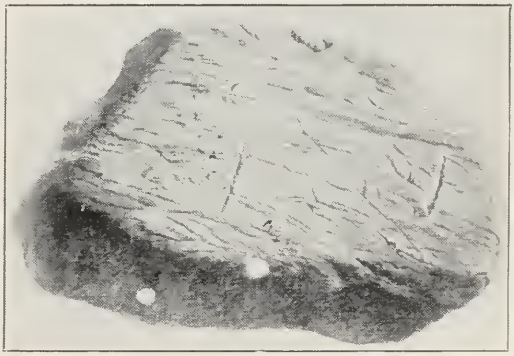
XVIII. Bonneville and Intermediate Embankments, near Wellsville, Utah, showing contrast between littoral and sub-aerial topography. (After Gilbert. U. S. G. S., Monograph I; Fig. 21.)

XIX. View on Salt Lake Desert, showing mountains half buried by lake sediments. (After Gilbert, see U. S. G. S., Monograph I: Pl. XXXVI.)



XX. Ripple Marks in Argillaceous Sandstone.
Shore of Lake Bonneville.

XXI. Section of Moraine, Mouth of Little Cottonwood Canyon,
Salt Lake Valley.



XXII. Glaciated Stone, from Little Cottonwood Moraine.

THE

GREAT SALT LAKE

PRESENT AND PAST.

BY

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OF UTAH.

THE DESERET NEWS,
SALT LAKE CITY, UTAH.
1900.

PREFATORY.

In some parts the following pages are reprints of articles that have appeared over the writer's signature in local and scientific periodicals; in other portions they are little more than a compilation of facts already of record. Perhaps sufficient excuse for the present publication may be found in the fact that reliable information regarding the Great Salt Lake is of difficult access to the general reader, inasmuch as it is mostly contained in the valuable though ponderous tomes of the national surveys. The popular writings on the subject, with some exceptions, have been criticized as extravagant and untrustworthy. The truth regarding Utah's Dead Sea is sufficiently impressive without recourse to fabulous embellishment, even if such were in any sense justifiable.

The writer has drawn freely on the valuable records of investigators, and acknowledgment of authorities has been made in place. J. E. T.

SALT LAKE CITY, UTAH,
July, 1900.

CONTENTS.

THE GREAT SALT LAKE.

PRESENT AND PAST.

I.

INTRODUCTORY.

The record of fact and tradition concerning the Great Salt Lake, as written by the hand of man, dates back a little more than two centuries; but a history of times far more remote may be read from Nature's manuscript, inscribed on the stony pages of ancient shores and in the sediment which formed the floor of the lake of by-gone days.

Though generally designated by the adjective "Great," the Salt Lake, as we shall presently see, is but a shrunken remnant of a vastly larger water body, which once existed as a veritable inland sea, completely filling the valley in the lowest portion of which the modern lake rests, and extending beyond the northern and western boundaries of the present State of Utah. To this ancient sea the name "Lake Bonneville" has been applied.

But the geological past of the "Dead Sea of Ameri-

ca" may well be left for later consideration; we can the better interpret such after an examination of existing conditions. It is, therefore, the lake of present and historic times to which attention is first invited.

Long prior to the time at which white men first trod the shores of this briny sea, strange stories of its existence and of the marvelous properties of its waters had found their way into civilized lands. In 1689 Baron La Hontan, a French traveler and explorer of note, gathered from the Indian tribes of the Mississippi valley their traditions of a great salt sea lying amid the solitude of the western mountains; and these stories, doubtless embellished by additions from his own imagination, the traveler sought to perpetuate. His narrative was first published in English in 1735. No facts of value were given by La Hontan concerning the lake; indeed there is room for doubt as to whether the water-body about which the Indians had talked to him was the Great Salt Lake.

In 1776 Padre Escalante, a Spanish official exploring for routes of travel, crossed the south-eastern rim of the Great Basin region, and followed the Timpanogos or Provo River (by him named Purisima) down to its termination in Utah Lake. From the Indian tribes of what is now Utah Valley he learned of a lake many leagues in extent, with waters extremely noxious and salty, lying in the valley northward. Escalante appears to have contented himself with this hear-say informa-

tion, for there is no record of his having reached the shores of Great Salt Lake.

Perhaps the truth regarding the first white man's visit to the lake may never be known. There have been many rival claimants for the honor of having discovered the briny waters, and historians have failed in their efforts to decide the question of priority.

There are many accounts of occasional visits to the lake or its vicinity by traders and trappers between 1820 and 1833; among such venturesome travelers may be named Miller of the Astor company; Provost (after who Provo City has been named), and Bridger, for whom some strongly claim the honors of discovery. Hubert Howe Bancroft, the voluminous writer on Pacific Coast history, is one who accords this credit to Colonel James Bridger. Bridger is said to have descended Bear River to its mouth in the lake, the journey having been undertaken to settle a wager as to the course of the river named.

Between 1831 and 1833 Captain Bonneville, a Frenchman in the service of the United States as an army officer, while traveling on leave, explored portions of the lake shores and wrote short descriptions, mostly geographical, which have proved of value. Several years later an account of Bonneville's explorations was given publicity by Washington Irving, whose book, "Adventures of Captain Bonneville," is well known. An attempt was made to attach Bonneville's name to

the salty lake, but without success. As already stated, the designation "Lake Bonneville" has now been applied to the ancient sea which preceded the Salt Lake of today.

In 1843 John C. Fremont, then Brevet-Captain U.S.A., sighted the lake from an elevation in Weber County now known as Little or Low Mountain, and considered himself the first discoverer of this mountain-sea. He likened himself to Bilboa discovering the Pacific. Fremont reached the lake and rowed upon its waters; but history denies him the distinction of having been first to discover or to navigate the lake. Fremont's visit was made in the course of a government expedition to the Rocky Mountains; and his report* is regarded as the earliest authentic record of the physical conditions of the region. His party included the renowned hunter and scout, Kit Carson, and tradition has it that a rude boat consisting of a tree-trunk hollowed-out Indian fashion, which was found on the shores of the lake after the settlement of the region by the Mormon people, was the identical craft used by Kit Carson. The boat in question is now to be seen at the Deseret Museum, Salt Lake City. There is much doubt as to the truth of the story, however, for more authentic accounts say that the explorations of Fremont and Carson

* "Report of the Exploring Expedition to the Rocky Mountains in the year 1842, and to Oregon and North California in the years 1843-44," by Brevet-Capt. J. C. Fremont. Washington, 1845.

on the waters of the lake were accomplished in rubber boats.

In 1849 and 1850 Captain Howard Stansbury, U. S. A., under government commission made a fairly thorough survey of the lake and the region contiguous. His report contained valuable data concerning the lake area, the depth, density, and composition of the water, and the extent of the shore line.*

Since the advent of the Mormon pioneers in 1847, and during the phenomenally rapid settlement of the region and the development of its varied resources, reliable observations have been recorded, both by residents and by competent investigators operating under private or government auspices. To Grove Karl Gilbert much praise is due for his elaborate and masterly study of the Great Salt Lake, particularly in relation to its past history. His work, "Lake Bonneville,"† is and will ever be a classic in the geological literature of America.

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* "Exploration and Survey of the Valley of the Great Salt Lake of Utah," etc., by Howard Stansbury, Capt. Corps Topographical Engineers, U. S. A. Philadelphia, 1852.

† Monographs of the United States Geological Survey, Vol. I:— "Lake Bonneville" by Grover Karl Gilbert; Washington, Government Printing Office, 1890.

II.

DESCRIPTIVE.

The Great Salt Lake today is an object of very general interest, attracting as it does the attention of scientist, lay-scholar, and curiosity-seeker alike. In the popular mind it holds a place as one of the strongest natural brines known, and as the site of attractive bathing resorts. To the chemist this remarkable body of water represents a practically inexhaustible reservoir of valuable material awaiting the potent influences of manufacturing industry. To the geologist it appeals as the dwarfed remains of an ancient sea, with the fossil evidence of its past history preserved in the deposits and sculpturing of its abandoned shores, and in the sediments of its desiccated floor.

The events characterizing its principal epochs may be determined with a fair measure of accuracy, and the story of its fluctuations recounts the succession of marvelous climatic changes through which the region of the Great Basin has passed.

As is generally known, the Great Salt Lake is the largest inland water body existing within the United States west of the Mississippi valley. It lies in the north central part of the State of Utah, between the parallels 111.8 degrees and 113.2 degrees longitude west from Greenwich, or 34.7 degrees and 36.1 degrees

west from Washington, and between 40.7 degrees and 41.8 degrees north latitude.

Owing to the frequent and great fluctuations in volume incident to climatic variations and other conditions of change, its area is inconstant, and the recorded surveys of the water surface show great discrepancies. In general terms its present dimensions have been recorded as follows: Average length, 75 miles; greatest width, 50 miles; extent of surface, 2,125 square miles.

The altitude of the lake surface is 4,210 feet above sea-level; and this fact alone is promise sufficient of many interesting results to the investigator, for at such a height the general conditions are unusual. The remarkable clearness of the atmosphere throughout the lake region appeals with force to the visitor, whose persistent underestimating of distance may be either amusing or annoying. From any convenient point of vantage the observer may survey the lake as a glassy continuation of the valley floor, with mountain-walled back grounds, which are broken on the central part of the western shore where the Great Salt Lake Desert and the lake itself have a margin in common.

ISLANDS OF THE LAKE.

Rising from the water surface are precipitous islands, appearing in their true character of mountain peaks and ranges, the lower part of their masses being submerged. Of these water-girt mountain bodies, Ante-

lope and Stansbury islands are the largest; and the others are Carrington, Fremont, Gunnison, Dolphin, Mud, and Hat or Egg islands, and Strong's Knob. The islands appear as continuations of the mountain ranges which diversify the contiguous land area, and an examination of their structure confirms this inference.

At present, communication between main-land and islands is effected by boat; though at low water periods, Antelope and Stansbury islands have been accessible by fording. Limited areas of the larger islands are under cultivation, and the regions have long been utilized as pasture lands. Some discoveries of mineralized deposits have been reported from the lake-washed mountains but thus far no profitable mining for metals has been accomplished.

The tiny hill whose summit rises from the briny waters as a rocky knoll, known as Hat or Egg island, is the principal rookery of the feathered frequenters of the lake. There congregate during the breeding season thousands of pelicans and gulls, and when they depart they are accompanied by the new generation of their kind, in uncounted numbers. A visit to this isle of nests at the proper time reveals the spectacle of great flocks of half-fledged pelicans, awaiting the arrival of their fisher-parents, or ravenously devouring the scaly contents of the parental pouches. The fish thus supplied are caught by the old birds at the mouths of the fresh water streams which feed the lake reservoir.

On the islands, which for ages have been monopolized by the birds as a nesting-ground, great deposits of guano have accumulated; and this material is now utilized as a valuable fertilizer.

The rivers which feed the lake all enter it on the eastern side; they depend upon the supplies furnished by the Wasatch and Uintah mountains. Of these streams the most important are the Jordan, which brings down from the south the surplus waters of Utah Lake, the Weber, and the Bear. Beside these there are several small streams locally designated as creeks, which deliver a moderate contribution during high-water seasons. Generally, however, the lower portions of the creek-beds are dry, the water having been diverted at higher levels for irrigation purposes. From the west no streams reach the lake, the few that rise on this side losing themselves in the desert plain, or disappearing entirely through evaporation.

The scenic glories for which the lake region is mostly famed depend not alone on mountain heights, or valley floor, neither on water expanse nor island cameos; not on one nor two nor all of these combined, pleasing though the combination be; these are but the canvas on which Nature paints with a richness beyond the colors of purely earthly origin. 'Tis when the sun-

beams fall aslant in the freshening dawn, or when the orb of day is sinking in the west, that the landscape and the water blaze forth with tints and shades which the artist strives in vain to catch and imitate.

A description of such a scene is a fit theme for the poet; the picture ought to be attempted by the master-hand alone. But the poet—frail as the rest of us—may substitute his witchery of rhythm and rhyme for the actual harmonies of the desert scene; and the painter may intrude his ideal into the picture. The truth here declared in Nature's language and colors calls for no embellishments. I trust rather the scientific observer, whose love for the beautiful,while no whit less than that professed and held by his brothers, poet and painter, is kept within the bounds of truthful decorum.

Let us call to our service the words of Prof. Russell, whose geological researches in these and contiguous parts have afforded him abundant opportunity for observation.*

"The scenery about this great lake of the Mormon land and in the encircling mountains is unusually fine,in spite of the aridity and the generally scant vegetation of the region. The sensation of great breadth that the lake inspires, together with the picturesque islands diversifying its surface, and the utter desolation of its

* "Lakes of North America" by Israel C. Russell, Professor of Geology, University of Michigan; Boston, Ginn & Co., 1895. pp. 78-79.

shores, give it a hold on the fancy and waken one's sense of the artistically beautiful in a way that is unrivaled by any other lake of the arid region. The unusually clear air of Utah, especially after the winter rains, renders distant mountains remarkably sharp and distinct, particularly when the sun is low in the sky and a strong side-light brings the sharp serrate crests into bold relief and reveals a richness of sculpturing that was before unseen. At such times the colors on the broad deserts and amid the purple hills and mountains are more wonderful than artists have ever painted, and exceed anything of the kind witnessed by the dweller of regions where the atmosphere is moist and the native tints of the rock concealed by vegetation. The hills of New England when arrayed in all the gorgeous panoply of autumnal foliage are not more striking than the desert ranges of Utah when ablaze with the reflected glories of the sunset sky. The rich native colors of the naked rocks are then kindled into glowing fires, and each canyon and rocky gorge is filled with liquid purple, beside which even the imperial dyes would be dull and lusterless.

"At such times the glories of the hills are mirrored in the dense waters of the lake, their duplicate forms appearing in sharp relief on the paler tints of the reflected sky. As the sun sinks behind the far-off mountains, range after range fades through innumerable shades of purple and violet until only their highest

battlements catch the fading glory. The lingering twilight brings softer and more mysterious beauties. Ranges and peaks that were concealed by the glare of the noon-day sun start into life. Forms that were before unnoticed people the distant plain like a shadowy encampment. At last each remote mountain crest appears as a delicate silhouette, in which all details are lost, drawn in the softest of violet tints on the fading yellow of the sky.

"To one who only beholds the desert land bordering Great Salt Lake in the full glare of the unclouded summer sun, when the peculiar desert haze shrouds the landscape and the strange mirage distorts the outline of the hills, the scenery will no doubt be uninteresting and perhaps even repellent. But let him wait until the cool breath from the mountains steals out on the plain and the light becomes less intense, and a transformation will be witnessed that will fill his heart with wonder."

III.

THE LAKE AS A PLEASURE AND HEALTH RESORT.

The peculiar advantages and attractions of the Great Salt Lake for bathing purposes were known to the earliest white explorers; and even prior to their visits, the Indians, who are not famous for their love of ablutions, had discovered the difference between a dip in fresh water and a bath in this natural brine. The aborigines who dwelt near the shores of Utah lake forty miles to the south, specifically known as the Timpanogotzis, informed Padre Escalante of the strange properties of the water. The Padre writes, "The other lake with which this one communicates is, as they informed us, many leagues in extent; and its waters are noxious and extremely salt, so that the Timpanogotzis asserted to us that when any one rubbed a part of his body with it he would feel an itching sensation in the moistened part."*

The peculiarity of the lake water as a medium for the bath lies in its rich content of dissolved mineral matter, and in the consequent high degree of density. Dr. L. D. Gale reported a specific gravity of 1.17 on a sample collected in 1850; with the rise of the lake and the corresponding dilution of the brine, the specific gravity

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* Translation from the original manuscript-journal of Padre Escalante, describing his journeyings from Santa Fe to Utah Lake, etc., in 1776; by Philip Harry; published in Capt. Simpson's Report, 1876; p. 494.

fell to 1.111 in 1869 (Prof. O. D. Allen), and to 1.102 in 1873 (Bassett); then the density increased as the lake waters became more concentrated, reaching 1.1225 in 1885, 1.261 in 1888, and 1.679 in 1892. In December 1894, the density was 1.1538, and in May 1895, 1.1583; in June 1900, it was 1.1576. These data will be presented in greater detail on a subsequent page.

It is seen that the Salt Lake brine is among the most concentrated and therefore the densest of natural waters; indeed it is surpassed in point of density by but one large water body—the Dead Sea.

As would be surmised of a liquid possessing so high a specific gravity, the Salt Lake water is extremely buoyant, and this fact the bather soon demonstrates to his fullest satisfaction. It is a physical impossibility for the human body to remain submerged, and the skilful swimmer may float without effort, rather upon than in the brine. One of the earliest accounts of bathing in the lake is that given by Captain Howard Stansbury in his official report; an abstract therefrom is presented herewith, with the simple comment that the multiplied experiences of many confirm his statements as to general properties and effects of the water, and show the circumstances of the individual experience described to be consistent and probable:

"We frequently enjoyed the luxury of bathing in the

water of the lake. No one without witnessing it can form any idea of the buoyant properties of this singular water. A man may float, stretched at full length, upon his back, having his head and neck, both his legs to the knee, and both arms to the elbow, entirely out of the water. If a sitting position be assumed, with the arms extended to preserve the equilibrium, the shoulders will remain above the surface. The water is nevertheless extremely difficult to swim in, on account of the constant tendency of the lower extremities to rise above it. The brine, too, is so strong, that the least particle of it getting into the eyes produces the most acute pain; and if acidentally swallowed, strangulation must ensue. I doubt whether the most expert swimmer could long preserve himself from drowning if exposed to a rough sea.

"Upon one occasion a man of our party fell overboard, and although a good swimmer, the sudden immersion caused him to take in some mouthfuls of water before rising to the surface. The effect was a most violent paroxysm of strangling and vomiting, and the man was unfit for duty for a day or two afterward. He would inevitably have been drowned had he not received immediate assistance. After bathing it is necessary to wash the skin with fresh water, to prevent the deposit of salt arising from evaporation of the brine. Yet a bath in this water is delightfully refreshing and invigorating."*

"* Exploration and Survey of the Valley of the Great Salt Lake of Utah," by Howard Stansbury, 1852, p. 212.

The force of waves on the lake is astounding to one who has had experience in troubled waters of ordinary density alone. Even a moderate disturbance gives to the shore breakers prodigious power, and affords the bather the exciting experience of heavy surf-fighting. Storms on the open lake are serious happenings to the small boats that navigate its surface, even though the atmospheric disturbance may be that of but an insignificant squall at sea.

As will be readily understood, boats for service on the lake must be of special construction, affording proper displacement in the dense water. A craft that would sink to the water line in sea-water would ride so high on the lake brine as to be top-heavy and unsafe.

The natural attractions of the lake as a pleasure resort have been recognized from the time of the first settlement of the valley. Long prior to the erection of bath houses and pavilion piers, the shores were frequented by pleasure-seekers with whom boating and bathing were favorite sports. At the present time there are a number of resorts at different places along the shore, but of these two only are of considerable proportions. These in the order of their establishment are Garfield Beach and Saltair Beach resorts. They are both situated at the southern extremity of the lake, within easy access by rail from Salt Lake City.

In this part, the lake shore and bottom, free from rocky irregularities and mud, is covered with a peculiar and uniform deposit of "oolitic sand," which forms an ideal bathing floor. Firm to a moderate degree, it is yet conveniently soft and elastic, affording to the wader and to all who desire to keep within the limits of shallow water the advantages of a prepared bottom.

SALTAIR.

The Saltair Beach resort is a monumental testimonial to the enterprising energy of Utah capitalists. The pavilion is situated thirteen miles due west from Salt Lake City, and may be reached by a twenty minute ride on the Salt Lake and Los Angeles railroad. The railway here runs over a recently desiccated portion of the old lake bottom, which preserves many features of actual desolation, and affords an illustration of what the entire valley was in the geological yesterday. Saline pools and playas appear as the shore is approached, and vegetation dies away, save occasional patches of wild sage, (*Artemisia tridentata*), greasewood (*Sarcobatus vermicularis*), and rabbit brush (*Lynosyris*).

The train runs on a pile-supported track 4,000 feet into the lake before the pavilion is reached. The buildings form a symmetrical group, with a large central structure connected with a semicircular extension at each end curving toward the lake. The architecture is af-

ter the Moorish style, and the general effect is as beautiful as the structure is substantial and serviceable. The pavilion was erected in 1893 at a cost of a quarter of a million dollars.

In length the buildings extend over 1,115 feet, with a maximum width of 335 feet. The top of the main tower is 130 feet above the water surface. Part of the lower floor serves as a lunch and refreshment pavilion; the area thus utilized is 151 by 252 feet. The upper floor in the main building is used as a ball room; its dimensions are 140x250 feet. The dancing floor is domed by a roof constructed after the plan of that covering the famed Salt Lake City Tabernacle, and the proportions of the two vast assembly rooms are nearly the same.

On the semi-circular sweeps which flank the central pavilion 620 bath-rooms are provided. The bathing appointments are of the best, and the many flights of stairs leading to the water reach the bottom at points giving a range of depth from fifteen inches to four feet. Deeper water may be reached at some distance outward. During the bathing season the observed temperature of the water ranges from 50 degrees to 86 degrees F.

At night the pavilion is brilliantly illuminated by means of electric lamps. There are 1,250 incandescent lights and 40 ordinary arc lights, with one arc light of 2,000 candle power surmounting the main tower.

As would be naturally expected, a resort of such at-

tractiveness is secure in the matter of patronage. The records show an annual total of over 160,000 visitors.

The buildings are supported on 2,500 piles each 10 inches in square cross-section, and driven 14 feet into the lake bottom. Owing to the peculiar nature of the formation, the piles are of unusual stability. To a depth of a few inches the bottom consists of loose or slightly compacted oolitic sand; for two feet or more beneath this is a layer of sand cemented by calcareous matter; then with a thickness of seven or eight feet comes a layer of sodium sulphate—the mirabilite of the mineralogist and the glauber salts of commerce—doubtless precipitated from the lake water during an earlier stage of its history.

In the work of pile-driving it was found to be practically impossible to penetrate this layer of "soda," even with the best steel-pointed instruments. A method at once simple and efficient was adopted. Through pipes, steam under moderate pressure was conveyed to the sodium sulphate bed; the substance dissolved at once, and the driving of piles became easy. Concerning the stability of the piles when driven, Mr. C. W. Miller, manager for the Saltair Beach Company, writes, "After the piling has been allowed to set for twenty-four hours, it is impossible to drive it even a quarter of an inch, though you might hammer the piling until you wore it down." This bed of mirabilite extends for an undetermined though certainly a very considerable area inland,

for wherever canals have been cut to a sufficient depth in connection with the salt ponds inshore, the substance has been encountered as a continuous layer, though of varying thickness.

GARFIELD.

The present Garfield Beach resort may be regarded as a development of years, the stages of which were marked by the successful operation of many minor establishments. As early as 1876 a small pavilion and about a hundred bath-rooms were erected at Lake Point—a little less than two miles beyond the site of the existing pavilion, on the line of the Utah and Nevada railway. This enterprise was carried on under railway auspices, at the instance of Hon. W. W. Riter. In 1885 Captain Thomas Douris built a pier, and provided bathing and boating facilities near the present location of Garfield pavilion. A year or so later the railway company constructed bath-rooms at Black Rock. But all of these temporary acommodations were superceded in 1887 by the construction of the commodious pavilion now in service. This comprises two hundred bath-rooms, and ample provisions for promenades and halls. Its original cost was over $70,000, to which may be added nearly half as much more for subsequent improvements. The attendance of pleasure-seekers at the Beach has reached a total of 84,000 in a single year. The resort is on the line of the Utah and Nevada road,

which now is operated as a branch of the Oregon Short Line railway.

In driving the piles for Garfield pavilion a layer of sodium sulphate, locally known as "soda," was struck, as already described in connection with the work at Saltair. As the simple method of using steam in penetrating the soda layer was not suggested, steel-shod piles had to be used; and even with such the work was not accomplished without difficulty and high cost.

Attempts have been made to procure a supply of artesian water at Garfield and at Saltair. Pipes have been driven on shore, and into the lake bottom. Good flows are generally struck at a depth of from 100 to 150 feet, but the water is always salty or brackish. All the potable water used at the resorts named is conveyed from a distance.

Beside boating and bathing, the lake offers attractions to the lover of the gun. Wild duck and other water fowl congregate in the brackish water near the mouths of inflowing streams, and on many of the lake islands.

The lake is steadily growing in popularity and favor as a pleasure and health resort. Situated in close proximity to the high roads of trans-continental travel, it is visited every year by multitudes. From the east it is reached by the Union Pacific and the Rio Grande West-

ern railways, and from the west by the Southern Pacific line.

The general purity of the atmosphere, the exhilarating effect of the lake-breezes, the benefits of altitude, and the pleasing climate unite in making the lake region a natural sanitarium. Lovers of pleasure and health-seekers flock to this mountain-girt lake in rapidly increasing numbers every year.

IV.

STATISTICAL AND GENERAL.

It is well known that an enclosed water body, such as a lake devoid of an outlet, is particularly sensitive to climatic changes. Such a lake rises and falls as evaporation increases or diminishes in relation to supply by precipitation. The variations in volume as shown by the shore-records of the Great Salt Lake are unusually large.

The fluctuations in surface area are even greater than would be expected from a study of the variable relations between supply and loss; and this fact is explained by the very gradual inclination of the shores. The entire valley is remarkable for its flatness, as any observer may see for himself if he will climb one of the hills in the vicinity of Salt Lake City; but even more striking is the small increase of water depth as one passes from the lake-shore outward.

A slight rise in the lake level results therefore in a great increase of water surface. As was pointed out by Stansbury, a rise of but a few feet would enable the lake to reclaim a large part of its former domain over what is now the Great Salt Lake Desert.

The writer has conversed with residents of towns near the shore who remember when the water's edge was in places two miles beyond its present line; and the

same people are able to point out the ruins of farm fences a mile inland from the present margin, marking the location of fields which were destroyed by the rising waters, and which are now left dry and barren.

We have of ready access two reliable maps of the lake, by comparison of which recent variations in the water area may be demonstrated. The earlier of these is Stansbury's map, based on work done in 1849 and 1850, at which time the lake stood at the lowest level observed by man; and the later map is that prepared under the direction of Clarence King in connection with the field work of the Fortieth Parallel Survey, dated 1869, when the water was approaching the highest stage of recent times. According to the first of these the lake covered 1,750 square miles; the second survey showed an area of 2,170 square miles.

As would be inferred from the foregoing facts, the average depth of the lake is subject to small and slow variations only. On the whole the lake is extremely shallow. In 1850 the greatest depth found was but 36 feet, and the average but 13 feet. Later, the lake rose 10 feet, with a consequent increase of water area through the submergence of the flat shore-borders, but with an increase of average depth not exceeding 5 feet. The maximum depth observed at the highest stage was 49 feet. The average depth of Salt Lake today is probably not more than 15 feet.

The fact that the lake is a closed water body with no

out-flowing stream, would indicate the certainty of variations in its volume, unless indeed the improbable chance of a constant balance between the supply furnished by precipitation, and the loss through evaporation were realized. A body of water provided with a channel of ready discharge may maintain a tolerably constant level, the outlet acting as a regulator and permitting the escape of the surplus water; but the level of a lake entirely enclosed will depend, as stated, upon the relation between the supply and the loss through evaporation.

For an undetermined period prior to 1850 or thereabouts, the Salt Lake had been steadily diminishing in volume. For ten or fifteen years after the time named the water oscillated with a tendency to rise; then it rose rapidly and reached its maximum height in the course of this increase of volume about 1872 or 1874. Although it is now sinking year by year, it has not yet reached its low level of 1850.

Antelope Island, one of the land bodies of the lake, is connected by a bar with the delta of the Jordan River; this bar is now under water at a depth of 3 to 8 feet. Fremont records that on August 13, 1845, he rode across the bar to Antelope Island, the water being in no part more than 3 feet in depth.*

There is a well-defined and regularly recurring annual oscillation of the lake, marked by a higher water

* Fremont's "Memoirs" I, p. 431.

level in May and June, and a low stage in the late summer months; but beside this, oscillations of wider duration are known to occur. A combination of evidence from many sources points to the following facts; they are presented in Gilbert's words:

"From 1847 to 1850 the bar was very dry during the low stage of each winter, and in summer covered by not more than 20 inches of water. Then began a rise which continued until 1855 or 1856. At that time a horseman could with difficulty ford in winter, but all communication was by boat in summer. Then the water fell for a series of years, until in 1860 and 1861 the bar was again dry in winter. The spring of 1862 was marked by an unusual fall of rain and snow, whereby the streams were greatly flooded and the lake surface was raised several feet. In subsequent years the rise continued, until in 1865 the ford became impassable. According to Mr. Miller, the rise was somewhat rapid until 1868, from which date until the establishment of the guages, there occurred only minor fluctuations."*

A bar connecting Stansbury Island with the mainland was dry in 1850. Since the rise of the lake in or about 1865, the bar has never been entirely above water, though at present it is fordable during the entire year. The islands have been used as herd grounds by the inhabitants of Salt Lake Valley, the cattle being trans-

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* "Lake Bonneville," p. 240; "Lands of the Arid Regions," ch. iv.

ferred from the shore or back during the low water periods. The Stansbury bar is 7 feet higher than the bar running to Antelope Island.

These fluctuations, while surprisingly great when placed in comparison with ordinary lake oscillations, are trifling as compared with the great variations in volume which marked the stages of Bonneville history. We observe current changes actually in progress, while the variations of earlier times we can but picture in imagination.

The aridity of the Great Basin is due to the very small precipitation of moisture and to the great evaporation resulting from the high temperature. Humid air currents traveling eastward from the Pacific suffer a condensation of their vapor before reaching the Basin; when they arrive their condition is changed to that of drying winds.

An estimate of the energy of the evaporation process may be made as follows: The preparation of salt from the lake water constitutes at present an important industry. In the process of manufacture, the lake brine is pumped into elevated conduits through which it is conveyed to large ponds; in the ponds it evaporates without artifical heat. The pond area, the pump discharge per hour, and the length of time during which the pumps have to be operated in order to keep the

water at the same level in the ponds, may all be determined. From the official reports of one of the salt companies, it is learned that their ponds cover 971 acres; that the pumps discharge 14,000 gallons of water per minute, and that when the ponds have been filled, it is necessary to operate the pumps to their full capacity from ten to twelve hours daily during the summer months in order to maintain the level. Making allowance at the start, as a guard against over-estimate, let us assume that the evaporating surface of the ponds is 1,000 acres in area. At the rate of 14,000 gallons per minute, 8,400,000 gallons would be delivered in ten hours. This represents the loss by evaporation per day of 24 hours. Considering the lake surface to be 2,125 square miles—the usually accepted area—the rate of evaporation shown above would indicate a daily removal from the lake of 11,424,000,000 gallons of water, or 342,720,000,000 gallons per month of 30 days. The weight of the water so lifted is 95,447,916 tons per day or 2,863, 437,500 tons per month. The same high rate of evaporation continues through at least three months of the year. The estimate here indulged in is founded on the unproved supposition that the rate of loss is the same over the deep parts of the lake body as from the shallow pond waters; it is evident indeed that such cannot be the case; but even if the numbers would more nearly represent the truth when halved, quartered, or divided by ten, the result is sufficiently astounding.

As is now generally known, there has been a notable increase in the water supply of the Salt Lake valley, and indeed of the entire Basin Region, within the period of human occupancy. The supply keeps ahead of the demands of the growing population. By way of example, I cite the following items of traditional history, for which information I am indebted to the Historian's Office, Salt Lake City: Between 1850 and 1860 the site of the present town of Kaysville was first occupied for habitation. For years after the time of first settlement, a dozen families composed the entire population, and the settlers were loath to welcome additions to their numbers, owing to scarcity of water. The tiny creek on the banks of which the diminutive and scattered village had been established, scarcely furnished water enough for the irrigation of the few small farms owned by the settlers. Kaysville now is a thriving little town with a population of over 1,800. Similar conditions have prevailed in the history of other towns on the lake margin. Forty-five years ago ten families composed the population of Farmington and fourteen that of Bountiful. These places are at present prosperous towns, the first with over a thousand inhabitants, the second supporting over 2,500 souls. The prevailing pursuit of the people is agriculture, and water is needed for every farm. Yet there is enough and to spare, and additions to the farming population are regarded as desirable.

To account for this remarkable increase in the water

supply, numerous theories have been proposed, most of them meeting with temporary favor, soon to be lost. Of such theories three are generally current; these are called respectively, the volcanic theory, the climatic theory, and the theory of human agencies.*

The volcanic theory supposes the increase to be merely an apparent rise in the lake volume, and this is ascribed to orogenic disturbances whereby the lake bottom has been deformed, and the water caused to recede from some parts and to overflow others. The hypothesis is untenable in the light of the fact that the elevation of lake level is real, indicating an actual increase in the water volume. The water has risen along the entire shore line. On the islands and along the mainland margin old storm lines are now submerged, and everywhere the shore has been transferred inland. Independent observation confirms the belief that the rising of the lake is due to an increase in the water supply of the entire hydrographic basin, for the streams have all grown in volume to a degree commensurate with the lake growth. The water body not only rose with comparative rapidity above a height which for an indefinite period had marked its maximum limit, but it maintained its higher level for more than a decade; and such a condition is not explicable on the supposition of a simple deformation of the bed. With reference to the general and actual rising of the water in opposition to

* "Lands of the Arid Regions," p. 67

any supposed increase which is apparent only, I quote from the "Lands of the Arid Regions," page 67:

"The farmers of the eastern and southern margins have lost pastures and meadows by submergence. At the north, Bear River Bay has advanced several miles upon the land. At the west, a boat has recently sailed a number of miles across tracts that were traversed by Captain Stansbury's land parties. That officer has described and mapped Strong's Knob and Stansbury Island as peninsulas, but they have since become islands. Antelope Island is no longer accessible by ford, and Egg Island, the nesting ground of the gulls and pelicans, has become a reef. Springs that supplied Captain Stansbury with fresh water near Promontory Point are now submerged and inaccessible; and other springs have been covered on the shores of Antelope, Stansbury, and Fremont Islands."

The climatic theory refers the phenomenon of increase to a permanent change in the conditions controlling precipitation and evaporation within the drainage basin. While the recorded observations of rainfall are few, an actual increase in precipitation is indicated. An increase of less than ten per cent would probably account for the observed phenomena, and the influence of climatic change appears to be a probable explanation, in part at least, of the greater supply.

Major Powell has advocated the claim of the theory of human agency. By the cultivation of the land, and

the deforesting of the hill slopes, man favors the rapid removal of the precipitated moisture through the increase of stream volume. Well covered soil retains the moisture whether it fall as rain or as snow, and in time returns it to the atmosphere through the medium of evaporation. The more completely the precipitated water is so held, the less reaches the lake through stream discharge; and conversely, as the streams are augmented the lake rises. Considering the theory of climatic change and that of human agency as the two hypotheses most worthy of credence, the writer of chapter iv of "Lands of the Arid Regions," says:

"On the whole, it may be most wise to hold the question an open one whether the water supply of the lake has been increased by a climatic change or by human agency. So far as we now know, neither theory is inconsistent with the facts, and it is possible that the truth includes both. The former appeals to a cause that may perhaps be adequate, but is not independently known to exist. The latter appeals to causes known to exist, but quantitatively undetermined. It is gratifying to turn to the economic bearings of the question, for the theories best sustained by facts are those most flattering to the agricultural future of the Arid Region. If the filling of the streams and the rising of the lake were due to a transient extreme of climate, that extreme would be followed by the return to a mean condition, or perhaps by an oscillation in the opposite direction, and a

large share of the fields now productive would be stricken by drought and returned to the desert. If the increase of water supply is due to a progressive change of climate forming part of a long cycle, it is practically permanent, and future changes are more likely to be in the same advantageous direction than in the opposite. The lands now reclaimed are assured for years to come, and there is every encouragement for the work of utilizing the existing streams to the utmost. And finally, if the increase of water supply is due to the changes wrought by the industries of the white man, the prospect is even better."

As has been stated, the lake is now steadily decreasing in volume. This cannot be regarded as evidence of a turn in the series of climatic changes toward a state of increasing aridity, nor as proof of less potent human influences. As population grows, the area of land brought under cultivation enlarges very rapidly, and many of the streams, which but a few years ago made important contributions to the lake volume, now send but an insignificant tribute; and in other instances the stream channels below the uplands are entirely dry during the greater part of the year. There is little ground for doubt that in the near future even the flood season contributions of water will be practically cut off, for the increasing demands of the growing irrigation system

will compel the construction of artificial reservoirs in the upper stream regions, and thus the water will be stored for subsequent distribution upon the land.

The geological evidence of a former desiccation of the lake is conclusive, and the industrial energy of man is assuredly contributing in a very effective manner to the process of present shrinkage; but that the desiccation shall again reach completion in the near future is by no means certain. As the lake surface diminishes, the area exposed to solar evaporation is lessened, and a level may be reached at which the loss by evaporation will be more nearly met by the stream supply.

V.

THE LAKE WATER.

The variation in volume and the consequent oscillations in level characterizing a lake without outlet, and the particularly striking example of such afforded by the Great Salt Lake have been already referred to. As shown by geological investigation, the lake has shrunk, from a level approximately 600 feet above the present surface to its existing volume, by desiccation alone. Thus through long ages the solid matter leached from rock and soil and carried into the lake by streams has been undergoing concentration, until the water has reached its present condition of unusual density. Analyses of samples of lake water collected at times of high and low level show great variations in dissolved solids, and these variations are of course approximately commensurate with the fluctuations in volume.

The first recorded determination of the solids dissolved in the lake water is that of Dr. L. D. Gale, published in Stansbury's report. Gale's results together with those of later examinations are presented here.*

* For compilation of analyses of Salt Lake water with a discussion of the same, see Monograph I., U. S. Geological Survey,—"Lake Bonneville," by G. K. Gilbert, pp. 252-254.

Solid contents and specific gravity of water taken from the Great Salt Lake:

Date of Collection.	*Specific Gravity.*	*Total Solids.* *Per cent by weight.*	*Total Solids.* *Grams per litre of sample.*	*Authority.*
1850	1.170	22.282	260.69	L. D. Gale.
1869 (summer)	1.111	14.9934	166.57	O. D. Allen.
August, 1873	1.102	13.42	147.88	H. Bassett.
December, 1885	1.1225	16.7162	187.65	J. E. Talmage.
February, 1888	1.1261	———	———	" " "
June, 1889	1.148	———	———	" " "
August, 1889	1.1569	19.5576	226.263	" " "
August, 1892	1.156	20.51	238.12	E. Waller.
September, 1892	1.1679	21.47	250.75	J. E. Talmage.
1893	———	20.05	———	J. T. Kingsbury.
December, 1894	1.1538	21.16	244.144	J. E. Talmage.
May, 1895	1.1583	21.39	247.760	" " "
June, 1900	1.1576	20.90	241.98	H. N, McCoy and* Thomas Hadley.

The difference existing between the writer's results from the sample collected September 1892, and those obtained by Waller on a sample taken during the preceding month, is greater than would be expected from the progressive concentration during so short an interval. It is more likely due to an actual difference between the samples, they probably having been taken from different parts of the lake.

The statements most commonly current regarding the solid contents of the lake water are based on the earliest examination by Gale. In 1889† the present writer protested against this excessive estimate of average composition, as at that time the lake was and for

* Specific gravity determined by Dr. McCoy: total solids by Mr. Hadley.

† "The Waters of the Great Salt Lake," by J. E. Talmage, Science (New York), December, 1889; vol xiv,, pp. 444—446.

many years preceding had been at a relatively high level and of corresponding dilution. The opinion was then expressed that "it would be more correct to quote the average contents of the Salt Lake water at sixteen per cent solid matters, than at twenty-two per cent" as was at that time most commonly done. It was pointed out however that the lake was then undergoing a process of rapid shrinkage, and the inference is plain that the proportion of total solids was correspondingly increasing. At the present time (June, 1900) the water has not yet reached the degree of richness chronicled by Dr. Gale. It would appear safe to say that the average of solid matter dissolved is about twenty-one per cent by weight at present.

Inasmuch as solids dissolved in natural water are frequently expressed in terms of grains per gallon, it may be interesting to transform some of the foregoing readings into the more common expressions. Let it be remembered that 10 grains of solid matter to the imperial gallon is the equivalent of .014 per cent by weight. The mean of the writer's analyses quoted above of samples taken in December 1885, (16.7162 per cent solids) and in August 1889, (19.5576 per cent) is 18.1369 per cent; this corresponds to 11,777.64 grains per gallon. For convenience of comparison these results are given below in connection with the re-

sults of analyses of other waters, potable and mineral, from Utah and other places. The gallon here referred to is the imperial gallon, containing 277.27 cubic inches; such a measure of pure water at the temperature of 62 degrees F. weighs 10 pounds avoirdupois, or 70,000 grains.*

Source.	*Total Solids expressed in grains per gallon.*	*Authority.*
River Loka, Sweden	0.05	Wells.
Boston, U. S., Waterworks	1.22	Johnston.
Loch Katrine, Scotland	2.3	Wanklyn.
Schuylkill River at Philadelphia	4.26	Johnston.
Detroit River, Michigan	5.72	"
Ohio River at Cincinnati	6.74	"
Loire at Orleans	9.38	"
Danube, near Vienna	9.87	"
Lake Geneva	10.64	"
River Rhine at Basel	11.8	Wanklyn.
Thames at London	18.5	"
Average of 12 artesian wells, Provo, Utah	18.6	J. E. Talmage.
Salt Lake City supply	16.92	"
Spring water, Provo, Utah	23.3	"
Formation Springs, Idaho	27.8	"
Octagon Spring, at Soda Springs, Idaho	126.66	"
Well water, Gunnison, Utah	148.01	"
"Ninety per cent Spring," at Soda Springs. Idaho	198.41	"
Warm Springs, Spanish Fork Canyon, Utah	413.72	"
Atlantic Ocean	2,688,00	Wanklyn.
Salt Lake	11,777.64	J. E. Talmage.
Dead Sea	17,064.42	"

As comparisons between the Great Salt Lake and the Dead Sea are common, the two lakes representing the highest known condition of natural concentration in large water bodies, the content of solid matter in the

* See "Domestic Science," by J. E. Talmage, second edition, p. 200—201; George Q. Cannon & Sons' Co., Salt Lake City, 1892.

Dead Sea water is of interest in the present connection. It must be remembered, however, that great discrepancy exists among published accounts of the composition of this water. Bernan gives 14,025.48 grains per gallon; Captain Lynch collected a sample at a depth of 1,110 feet, and found it to contain 18,902 grains per gallon. The amount given in the foregoing statement, (17,064.42 grains per gallon) was determined by the author in a sample taken from the Dead Sea in April 1886, by Dr. J. M. Tanner.

The composition of the solid matter existing in the lake water is a subject of importance. Some results of analyses are here given:

Analyses of Salt Lake water, acids and bases theoretically combined; expressed in percentage of weight of samples:—

	Gale.	*Allen.*	*Bassett.*	*Talmage.*	
	1850.	*1869.*	*1873.*	*1885.*	*1889.*
Sodium chloride	20.20	11.86	8.85	13.586	15.743
Sodium sulphate	1.83	0.93	1.09	1.421	1.050
Magnesium chloride	0.25	1.49	1.19	1.129	2.011
Calcium sulphate	......	0.09	0.20	0.148	0.279
Potassium sulphate	......	0.53	....	0.432	0.474
Potassium chloride	......	......	1.89	......	......
Excess of chlorine	......	......	0.20	.....	......
Total	22.28	14.99	13.42	16.716	19.557

Allen reports traces of boric and phosphoric acids. Lithia is also present in quantities sufficient to give the spectroscopic effect with little difficulty.

In the analyses given on the authority of the writer, the data represent in most instances averages of several determinations.

One of the most comprehensive of the analyses published is that by E. Waller, giving the results of examination on a sample collected August 9, 1892.* The report is as follows:

Analysis of a sample of the water of Great Salt Lake collected August 9, 1892.

[Expressed in grams per litre; Specific Gravity, 1.156]

Elements and Radicals.		Probable Combination.	
Sodium	75.825	Sodium chloride NaCl	192.860
Potassium	3.925	Potassium sulphate K_2SO_4	8.756
Lithium	0.021	Lithium sulphate, Li_2SO_4	0.166
Magnesium	4.844	Magnesium chloride, $MgCl_2$	15.044
Calcium	2.424	Magnesium sulphate, $MgSO_4$	5.216
Chlorine	128.278	Calcium sulphate, $CaSO_4$	8.240
Sulphur trioxide	12.522	Ferric and aluminium oxides $Fe_2O_3 + Al_2O_3$	0.004
Oxygen in sulphates	2.494	Silica, SiO_2	0,018
Ferric oxide and aluminium oxide	0.004	Surplus sulphur trioxide, SO_3	0.051
Silica	0.018		
Boron oxide	Trace	Total	230.355
Bromine	Faint trace	Total solids by evaporation	238.12
		Total solids [duplicate]	237.925

The most striking discrepancy between the results of Waller's analysis and those recorded in the table on page 59, is the absence of sodium sulphate in the list of probable combinations presented by Waller, and the presence of this substance in every other analysis herein recorded. As is generally understood, an ultimate

* See "School of Mines Quarterly" (Columbia College, New York,) vol. 14, 1892. p. 58. Quoted with approving comment by I. C. Russell in "Lakes of North America," Boston, 1895, p. 81.

chemical analysis gives the proportions of elements and radicals present; the combinations of these into definite salts, etc., is attended with some uncertainty as to accuracy. Waller has evidently combined all the sodium with chlorine, as sodium chloride or common salt, which certainly is the most abundant substance in the solid residue yielded by the lake water. Nevertheless sodium sulphate is known to exist in the lake brine, for, as shall be hereafter shown, a copious precipitation of the sulphate occurs whenever the water falls to a certain critical degree of low temperature. It is safe to say that many thousands of tons of the substance are deposited, some of it thrown by wave action upon the shores, in the course of every cold winter. And that an abundant deposition of sodium sulphate has taken place during a prior period of lake history has been already affirmed on the conclusive evidence afforded by the thick bed of the substance encountered in the driving of piles at Saltair and Garfield and in the cutting of canals on the neighboring shore lands. (See pp. 39, 41) Gilbert estimates the quantity of sodium sulphate contained in the lake water at thirty millions of tons.*

The source of the solid matter contained in natural waters is found to be the rock and soil through which the water passes, either by downward percolation and flow, or by upward passage under pressure. If such rocks

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* "Lake Bonneville," Monograph I, U. S. G. S., 1890; p. 253.

supply alkaline chlorides in excess, the evaporation of the water so charged will yield salt; if alkaline carbonates be the principal substances dissolved out from the rocks, alkaline residues will result from evaporation. It is evident that the streams supplying Great Salt Lake have traversed salt-bearing formations.

The composition of the waters flowing into the lake presents itself as a subject of interest in this connection. The streams from the Wasatch and Uintah mountains, which constitute the greater part of the lake supply, while carrying in solution nearly double the quantity of dissolved solids usually present in river water, (due rather to the unusual evaporation from their surface incident to the arid conditions than to more active solution from the rocks) give nevertheless no indication of mineral contents to the taste or other senses. Analyses of the principal waters supplying the lake give an average of about 0.2446 part of dissolved mineral solids per thousand.

Beside the rivers and creeks from the adjacent mountains, the lake has other sources of supply from fissure springs, which open at points on the shore or on the bottom. Few of these springs are markedly saline, and but one is known to be excessively so. Their content of salt is probably derived from the former sediments of the region.

It is estimated that the combined waters from surface streams and springs would probably contain less than double the percentage of solids held by the surface streams alone. Prof. Russell's assumption* is, that on the evidence now within reach, the combined spring and stream waters supplying the lake contain about 0.3 part solid matter in a thousand, or three one-hundredths of one per cent. Such a proportion of mineral matter, even if wholly common salt, would not reveal itself to the taste; and it is safe therefore to conclude that but for the concentrating effect of evaporation the lake would belong to the category of fresh-water bodies.

The enormous quantity of saline matter held in this lake of brine affords a striking example of the effect of concentration long continued. As stated, few of the inflowing streams are rich in salt. The Malad river is an exception; in its lower part this stream becomes brackish from the contributions of saline springs.

The evaporation, which has been in uninterrupted progress for ages past, has produced a nearly saturated brine. Along the lake margins, in partly-isolated areas, the shallow water has already begun to deposit salt; but in the open lake the water yet holds its salt in permanent solution. Russell records that in 1880 the water

* "Lakes of North America, p." 82,

between Stansbury Island and the mainland was floored by a glistening pavement of salt, strong enough to support a horse and rider over the greater part of the area. It is evident that the Salt Lake, while approaching a degree of concentration equal to that of 1850, has not yet become a thoroughly saturated brine. Nevertheless, at low temperatures an abundant precipitation of sodium sulphate occurs, as already stated. During the winter season, as the temperature sinks below a critical point, somewhere near the freezing point of fresh water, the sulphate separates from the water in the crystallized form as Mirabilite. As the separation takes place, the lake water becomes opalescent. Much of the precipitate is heaped upon the shore by wave action; and under particularly favorable conditions the shore deposit is over a foot in depth. When the water is warmed to the critical point of temperature, the crystalline substance is rapidly re-dissolved. Clusters of large and perfectly formed crystals may be found during cold weather on the posts supporting the bath houses, and on other stationary solid objects submerged in the lake.

The analytical data given show that the lake water is a concentrated brine, with sodium chloride greatly predominating, and with magnesium chloride and sodium sulphate existing also in large proportions. Most of the saline lakes of the Great Basin hold alkaline and earthy carbonates in solution, and the absence

of such from the Salt Lake water has been a subject of much comment. In this respect the Salt Lake compares closely with the Dead Sea, though widely differing in other respects, notably in the predominance of sodium over magnesium salts. The sulphates delivered to the lake by the contributing streams remain in solution, except, as specified, at low temperatures. Calcium carbonate, however, is precipitated as soon as the stream-water which carries it reaches its briny receptacle. A similar phenomenon is observed in the calareous sediments at the mouths of many rivers.

The calcium carbonate which analysis proves to exist in no inconsiderable quantity in most of the inflowing streams, and which diligent search has thus far failed to reveal in the lake water, is accounted for by the accumulation of calcareous particles along portions of the shore, particularly at the southern extremity. This material, commonly known as oolitic sand, is found in spherules, ranging between the size of No. 10 and No. 8 shot. By wave action it is drifted upon the shore and in some places it constitutes dunes several yards in depth. The fact that it is confined to the shore suggests the possibility of the rounded form being the result of rolling. The globular bodies possess a concentric structure, and in many cases a nucleus of silica is detectable. Dr. A. Rothpletz has advanced the theory that the ooliths of the Salt Lake are a product of the algae which exist along the shores. He claims

that the stones are generally covered with colonies of Glaeocapsa and Gloeothecae, which organisms are known to excrete calcium carbonate; and he holds that most of the marine ooliths, at least those characterized by concentric and radial structure, are the products of lime-excreting schizophytes.* Rothpletz's views have not been generally approved. While the oolitic sand is the only abundant shore accumulation of calcium carbonate, it is probable that a marly deposit is forming with other lake sediments in the deeper parts.

* Botanisches Centralblatt, 1892, p. 35.

VI.

LIFE IN THE LAKE.*

The popular literature of the day persists in asserting that no living thing exists or can exist in the dense brine of the Great Salt Lake. There is little excuse for the perpetuation of such an error; yet cyclopedias and school geographies and magazines continue to reiterate the false statements. It is readily seen that the conditions prevailing in the lake are not favorable to the existence of the ordinary aquatic forms of life; and that cases of adaptation to life in the brine would naturally be rare.

Of animals but few species have been found in the lake, but of these few two are represented by swarming numbers. Among the animal forms already reported as common to the lake, the writer has confirmed the presence of four:—(1) *Artemia fertilis*, Verril; (2) the larvae of one of the Tipulidae, probably *Chironomus oceanicus*, Packard; (3) a species of Corixa, probably *Corixa decolor*, Uhler; (4) larvae and pupae of a fly, *Ephydra gracilis*, Packard.

The larvae of the *Ephydra* are found in abundance amongst the algae that strew the shores or appear as surface patches in the shallow parts; while the mature

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* A portion of the matter presented under this sub-title has already appeared as an article by the writer in "The American Monthly Microscopical Journal," vol. 13, pp. 284-286.

insects, as small black flies, swarm along the shores where conditions have proved favorable for their development. The larvae of the tipula may be taken anywhere near shore during the warm months; and the pupa cases of both species are often washed ashore in great numbers, where they undergo decomposition with disagreeable emanations.

Of the lake animals, the *Artemia fertilis* (or *Artemia gracilis*) commonly known as the brine shrimp, exists in greatest numbers. They are tiny crustaceans, seldom exceeding one-third inch extreme length. They may be found in the lake at all seasons, though they are most numerous between May and October. I have taken them in the midst of winter, when the temperature of the water was far below freezing point; it will be remembered that the concentrated brine of the lake never freezes. The females greatly preponderate; in fact, during the colder months it is almost impossible to find a male. In the latter part of the summer the females are laden with eggs, from four to sixteen having been repeatedly counted in the egg pouch. The males are readily recognized by the very large claspers upon the head. (See plate XII). The shrimps are found near shore during calm weather, but rain or wind drives them into the lake. At times they congregate in such numbers as to tint the water over wide areas.

They are capable of adapting themselves to great variation in the composition of the water, as must necessarily be the case with any tenant of the Salt Lake. I have specimens of the artemiae gathered from the lake in September 1892, and the water then taken showed on ananlyses, 14,623.23 grains of dissolved solids to the imperial gallon, the greater part of this being salt. Indeed, I have captured the creatures in the evaporating ponds of the salt works, where the brine was near its point of saturation.

It is not difficult to accustom them to a diluted medium; I have kept them alive for days in lake water diluted with 25, 50, 80 and 90 per cent fresh water, and from eight to eighteen hours in fresh water only. Of course the changes from brine to fresh water were made gradually, though a sudden transfer from the lake brine to fresh water or even to distilled water is not followed by speedy death. On the contrary, the creatures live for hours after such sudden change, with few signs of discomfort or inconvenience except their inability to rise in the water of low density.

The ability of the shrimps to withstand the effects of rapid dilution of the medium is surprising if we assume that their tissues are ordinarily impregnated with the salt of the lake brine. The violent osmosis between the dense fluids of the tissues and the fresh water without would appear to insure disruption. It is possible, however, that the tissues do not absorb the brine in

its entirety; indeed, if the shrimps just taken from the lake be subjected to a single quick rinsing with fresh water, they are but slightly salty to the taste.

During a cruise upon the lake in September 1892, our party found the crustaceans swarming in the open water. When near the middle of the lake, with a small tow-net we gathered a quart of the shrimps in the course of a few minutes. Thereupon we resolved upon an experiment the subsequent recital of which has shocked the gastronomic sensibilities of many friends. Reasoning that the bodies of the artemiae are composed largely of chitin, we concluded that the question of their palatability was at least worthy of investigation. By a simple rinsing with fresh water the excess of lake brine was removed, after which the shrimps were cooked with no accompaniments save a little butter and a suggestion of pepper. They were actually delicious. If the shrimps could be caught and preserved in quantity, I doubt not they would soon be classed as an epicurean delicacy. Repeated washings for five minutes removed the brine so completely that salt had to be added to make the dish palatable.

As to their food—in captivity they live upon meat, bread, or vegetables, in fact upon almost anything in the nature of food; and they are not slow in attacking the bodies of their own dead. In the lake they probably subsist upon the organic particles brought down by rivers, upon the algae which flourish about the shores,

and upon the larvae and pupae of the insects tenanting the water.

The mounting of specimens of the brine shrimp for permanent microscopical use requires considerable care and some modification of the ordinary procedure. Most of the common mounting media cause the delicate structure to become distorted, or produce such a degree of transparency as to render the object invisible. A method which has given the writer good results consists in mounting the specimen in a preparation of lake brine with corrosive sublimate and an alcoholic solution of carbolic acid. To this fluid, placed upon the slide, the living artemia is transferred directly from the lake brine; the creature dies quickly, and in so doing spreads itself most perfectly. While objects so prepared are of admirable arrangement and definition as temporary mounts, the structure is liable to break down after a lapse of months.

A better permanent result may be secured as follows: Place the artemiae in Peryeni's fluid; they will be quickly killed, and will be hardened by the action of the fluid in from 12 to 20 hours. They should then be transfered to alcohol, the strength of which should be increased by degrees, beginning with 40 per cent and running to 95 per cent. The structure will take some of the analine stains quite readily; it may then be carried

through absolute alcohol with phenol, then through phenol and turpentine, and be permanently mounted in balsam.

In point of zoological classification it may be said that the brine shrimp is a crustacean, and is generally referred to the order *Phyllopoda* one of the divisions of the sub-class *Entomostraca*. In all phyllopods except those of the highest family of the order, a carapax covers the greater part of the body. To this highest family—the *Branchipodidae* the artemia belongs.

The *Artemia* is distinguished from a nearly allied form, the *Branchinecta* in the following particulars: *Artemia* possesses eight abdominal segments; the second pair of antennae or claspers, which are highly developed in the male, are flat and of triangular shape in the second joint; the ovisac of the female is short. *Branchinecta* has nine segments composing the abdomen; the claspers are simple and cylindrical; the ovisac is long and slender.

Commenting on the structural and other relations between these two forms,* Prof. J. S. Kingsley says: "Under ordinary circumstances these [differences] would be considered as of generic value; but what shall we say when we know the results of the observations and experiments of the Russian naturalist, Vladimir Sch-

* Riverside Natural History, vol ii., pp. 40-41.

wankewitsch? Condensed from his account these were as follows: In 1871 the spring flood broke down the barriers separating the two different lakes of the salt-works near Odessa, diluting the water in the lower portion to 8 degrees Baume, and also introducing into it a large number of the brine shrimp, *Artemia salina*. After the restoration of the embankment the water rapidly increased in density, until in September 1874, it reached 25 degrees of Beame's scale and began to deposit salt. With this increase in density a gradual change was noticed in the characters of the artemiae, until late in the summer of 1874, forms were produced which had all the characters of a supposed distinct species, *Artemia muehlausenii*. The reverse experiment was then tried. A small quantity of the water was gradually diluted, and though conducted for only a few weeks, a change in the direction of *Artemia salina* was very apparent.

"Led by these experiments he tried still others: Taking *Artemia salina*, which lives in brine of moderate strength, he gradually diluted the water, and obtained as a result a form which is known as *Branchinecta shaefferi*, the last segment of the abdomen having become divided into two. Nor is this change produced by artificial means alone. The salt pools near Odessa, after a number of years of continued washing, became converted into fresh water pools, and with the gradual change in character, *Artemia salina* pro-

duces first a species known as *Branchinecta spinosus*, and at a still lower density *Branchinecta ferox*, and another species described as *Branchinecta medius*."

Observations on the artemiae of the Salt Lake under conditions of slow increase or decrease of the brine density indicate the occurrence of changes in structure, but no long continued experiments of conclusive results have been reported.

The artemia is interesting to the zoologist as furnishing an example of parthenogenesis, i. e., reproduction by means of unfertilized eggs. Siebold of Munich has investigated this subject, and he announces that with the entomostracans, *Apus* and *Artemia*, this parthenogenic reproduction is common. He reared several broods composed entirely of females; yet from these, eggs were produced which hatched vigorous young. Packard treats parthenogenesis as a modified process of reproduction by budding.

The eggs of the artemia are capable of sustaining long continued drought without losing their vitality. Eggs have been sent in mud from the Salt Lake to Munich, Germany, where they have been successfully hatched by Siebold. It would be interesting to determine whether the fertilized eggs and those of parthenogenetic origin are of equal vitality under unfavorable conditions. In the light of known facts concerning reproduction among other forms, it would be reasonable

to expect that unfertilized eggs would prove less able to withstand vicissitude.

The following remarks by Gilbert* regarding the brine shrimp are of interest: "Packard ascribes the phenomenal abundance of the *Artemia* to the absence of enemies, for the brine sustains no carnivorous species of any sort. The genus is not known to live in fresh water or water of feeble salinity, but commonly makes its appearance when feebly saline waters are concentrated by evaporation. It has been ascertained that a European species takes on the characters of another genus, *Branchinecta* when it is bred through a series of generations in brine gradually diluted to freshness; and conversely, that it may be derived from *Branchinecta* by gradual increase in the salinity of the medium. It is found, moreover, that its eggs remain fertile for indefinite periods in the dry condition, so that whatever may have been the history of the climate of the Bonneville Basin, the present occurrence of the *Artemia* involves no mystery. During the Bonneville epoch its ancestors may have lived in the fresh waters of the basin, and during the epoch of extreme desiccation, when the bed of Great Salt Lake assumed the playa condition, and was dry a portion of the year, the persistent fertility of its eggs may have preserved the race. Or, if the playa

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* "Lake Bonneville," p. 259. See also Twelfth Annual Report U. S. Geol. and Geogr. Survey of the Territories, 1883, Part 1, pp. 295-592, particularly pp. 330-334.

condition with its concomitant sedimentation was fatal to the species, it may be that the alternative fresh water form survived in upper lakes and streams of the basin so as to re-stock the lower lake whenever it afforded favorable conditions."

The lake flora has received even less attention than has been bestowed upon its limited fauna. The existence of plant-life in the water is indicated by the abundance of animal life therein, and examination confirms the inference. The shore waters show an extensive vegetable growth, principally, perhaps entirely, of algae. A number of species seem to be indicated from the widely varying colors of the vegetable masses, and three have been recognized. Diatoms have been found in the brackish waters of the playa-pools ashore, and diatomaceous deposits make up part of the old lake beds.

Much has been said at different times as to the possibility of adapting fish to a life in the lake. In the absence of experimental data it would be rash to conjecture; though it would appear unlikely that fish could thrive in such a brine. Yet the fear expressed, that even if fish could be accustomed to the lake water they would starve unless artificially fed, is unfounded, for the waters contain an abundant food supply—crustaceans, insect larvae and pupae, and algae.

The fauna and flora of the Great Salt Lake are subjects inviting thorough investigation.

VII.

ECONOMIC IMPORTANCE OF THE LAKE.

The composition of Salt Lake water is such as to warrant the assurance of the lake becoming a valuable source of useful products. Indeed these briny waters have already begun to yield of their chemic riches, which, as guaged by the standard of human needs, are inexhaustible. The most abundant solids dissolved in the water are sodium chloride (common salt,) magnesium chloride, and sodium sulphate. Of these the first and the last named are easily separable.

The preparation of common salt from the lake water has been carried on since the early settlement of the region. The salt first produced acquired a bad reputation owing to its impurity; but this defect was due to carelessness or ignorance in the process of manufacture. The most primitive method consisted in constructing low dikes along the shore; over these barriers the waves carried large quantities of brine during times of storms, and the water thus imprisoned was allowed to evaporate by solar heat resulting in an abundant yield of impure salt. The evaporating pools were in some instances below the lake level, and little opportunity was given for the removal of the mother

liquors after the crystallization of the salt. The brine was allowed to evaporate to dryness, or at best the salt deposit was gathered from the mother liquor with little chance of purification, by draining. The crude product thus obtained contained, of course, all the impurities which ought to have been separated by the removal of the mother liquor. In consequence, Salt Lake salt was in ill favor; it was pronounced unfit for dairy use because it refused to remain properly incorporated with the butter, some of its ingredients appearing as an efflorescence on the surface.

Prior to very recent times, Utah presented an unenviable spectacle by importing salt into this, the richest salt region of earth. Now, however, the refined salt is in demand as one of the best and purest products in the market. A number of large salt-works have been established on the shores of the lake, and the industry is of assured and increasing success.

The most important producers of salt from the lake have been, in the order of their successful operation, the Jeremy Salt Co., the Inland Crystal Salt Co., and the Intermountain Salt Co. The first named has suspended, and the other two are consolidated under the name, Inland Crystal Salt Company. This company is now operating its plant on a large scale, producing all grades of salt from the coarse product used for metallurgical and packing purposes, to the finest table salt. Another establishment, the Saginaw Salt Co., is in business on

the east shore, in Davis county, but there crude coarse salt only is produced.

The process of manufacture employed by the Inland Crystal Salt Company is thoroughly efficacious and satisfactory; and as it represents the highest attainment in salt manufacture from natural brine here or elsewhere, and at the same time demonstrates the profits of this important industry in this region, it merits attention.

The lake brine is lifted by means of centrifugal pumps to a height of fourteen feet above lake level; it is then conveyed through flumes to the settling and evaporating ponds which are situated from one to two miles inland. The ponds cover about fourteen hundred acres of land, not all of which, however is in use every season. The pumps pour into the flumes about fourteen thousand gallons of brine per minute, and are kept in operation about ten hours daily during the pumping season of about 150 days beginning usually in March. By the time the ponds have been filled the evaporating season is well advanced, and about the same supply of water is required during the warmer months to maintain a constant level. No accurate record of pumping hours is kept at the plant, the work being regulated so as to maintain the level of the brine in the ponds. Long continued rains, which, however, are of rare occurrence except in the early part of the season, cause a

rise in the ponds, and at times necessitate the return of part of the brine to the lake to prevent overflow.

A portion of the pond area is used as a settling basin wherein the water deposits its suspended matters; thence is is conveyed to the evaporating ponds proper. The evaporation is accomplished by solar heat alone. The season lasts about four months during which a layer of salt with an average depth of six inches deposits. This affords a practical yield of about 900 tons to the acre, or at the rate of 150 tons per inch depth per acre. The saline mud forming the pond floor is practically water-tight.

About one-tenth of the amount of brine carried to the ponds is returned to the lake as a mother-liquor after the deposition of the crystals. This frees the salt from most of the magnesium compounds, and from sodium sulphate; it will be remembered that these were the substances which rendered the product of the more primitive methods unfit for use.

The salt harvest begins in late August or early September. Movable rails are laid into the ponds, and the crop is gathered into hand cars. The material is then piled in symmetrically shaped heaps, and, as required is conveyed to the refinery or to the railway for shipment as crude salt.

With the entire pond area in service a yearly crop of over a million tons is possible. For such a supply there

has been as yet no adequate demand, and the richest harvest reported for any year is 150,000 tons.

The manager of the plant reports on cost of production as follows: "Common labor is paid for at a rate ranging from $1.50 to $2.00 per day. The expense of manufacture is the cost of pumping the brine from the lake to the harvesting ponds, which, estimating interest on cost of apparatus for pumping, flumes, ponds, etc., is as near as can be estimated 50 cents per ton. In addition to the foregoing the salt after depositing must be harvested and piled, which, under contract costs 25 cents per ton. The coarse salt is sold on the cars at the works at a dollar per ton."

The refining process may be summarized under the follow operations: —

(1.) The crude salt is run through a Hersey drying cylinder, heated by steam.

(2.) The dried salt is subjected to fan action, whereby the fine powder, which includes practically all the objectionable sodium sulphate, is removed.

(3.) The granular salt is then ground to the varying degrees of fineness required for dairy salt, table salt, etc.

The lake salt so prepared is of a particularly high grade of purity; indeed, it challenges comparison with commercial salt from any other source. The company

reports analyses showing for the lower grades 98 per cent and for the better kinds 99 per cent sodium chloride. Analyses made by the writer a few years ago showed the following composition of samples procured by purchase in the retail market:

	Refined salt made by the Inland Salt Co. 1889.	*Table salt Inland Salt Company.*	*Coarse salt Jeremy Salt Company.*	*Table salt Jeremy Salt Company.*
Sodium chloride.........	98.407 %	98.121 %	98.101 %	98.300 %
Calcium chloride.........	.371	.311	.322	.345
Calcium sulphate........	.650	.422	.364	.680
Magnesium sulphate..	.030	.022	.021	.042
Moisture	.442	.911	.952	.158
Insoluble matters......	.102	.201	.214	.472
Loss and error......		.012	.026	.003
	100.002	100.000	100.000	100.000

The powder separated by fanning after the drying process affords material for a valuable by-product. This powder consisting mostly of fine salt mixed with sodium sulphate, is worked up with sulphur and is molded into large blocks for use on cattle and stock ranges. The demand for this "cattle-salt" is said to be greater than the supply from the fan-powder alone.

Common salt is practically the only chemical compound derived from the lake on a commercial scale, though the possibility of obtaining cheaply from the brine an extensive array of chemical products is readily apparent. In the statement of the composition of lake water before given (see page 59) the presence of sodium sulphate is shown. This substance in a prepared state

is known as Glauber-salt; as a naturally-occurring mineral it is called Mirabilite.

The deposition of glauber-salt from the brine has been mentioned as a regular winter occurrence. The substance separates in the crystalline condition, and even as found upon the shores where it has been heaped by the waves, it is of a remarkable degree of purity. Very pure samples may be broken off as crystalline aggregates from any submerged support. The following figures represent the averages of the writer's analyses on a number of samples collected from opposite sides of the lake:

	1. *East shore deposit.*	2. *West shore deposit.*
Sodium sulphate	43.060	42.325
Sodium chloride	.699	.631
Calcium sulphate	.437	.267
Magnesium sulphate	.025	.018
Water	55.070	55.760
Insoluble matters	.700	.756
Loss and error	.009	.243
	100.000	100.000

For purposes of comparison it should be known that chemically pure Mirabilite consists of anhydrous sodium sulphate, 44.1 per cent, water, 55.9 per cent.

When the temperature falls to the critical point the lake-water rapidly assumes an opalescent appearance from the separation of the sulphate. The substance sinks as a crystalline precipitate, and large quantities are thrown by the waves upon the beach. Under favorable conditions the shore may be covered to a depth of

several feet with crystallized mirabilite. On several occasions the writer has waded through the crystalline deposit sinking at every step to the knees.

The substance must be gathered, if at all, soon after the deposit first appears; for if the water reach the critical temperature on the ascending scale, the whole deposit is again taken into solution. The re-solution is a rapid process, a single day sometimes sufficing for the complete disappearance of all the deposit within reach of the waves. Warned by experience, the collectors heap the stuff upon the shores above the lap of the waves; in this situation it is comparatively secure. The work is easily accomplished by the use of horse-drags and scrapers. Large quantities of the mirabilite are yet to be seen in heaps—remaining from the harvesting of years ago. To a depth of a few inches the material effloresces, but within the heaps the hydrous crystalline condition is maintained.

The temperature at which the mirabilite separates has not been accurately determined. That we are concerned with but a small range of temperature is evident from the sudden appearance and disappearance of the solid precipitate as the temperature varies. Gilbert says* that the precipitation begins when the water falls below 20 degrees F. I have reason to believe that the critical temperature is higher than this.

* "Lake Bonneville," p. 253.

I camped with a party by the lake shore in the early days of January 1895, with the main purpose of ascertaining the temperature of the mirabilite separation; but the weather, which for days prior to our visit had been cold, moderated and soon grew unusually warm. The following observations are incorporated for illustration: January 3, 11 a. m., temperature of water off pier as determined by five thermometers, 35.8 degrees F.; temperature of air in neighborhood, 41 degrees F.; during a period of two hours the temperature of the water as indicated by self-registering instruments, reached a minimum of 35.5 degrees F.; yet the sulphate was then separating and crystals were readily obtained by dredging. On the same day crystals of mirabilite formed on the cord attached to the submerged self-registering thermometer when the instrument recorded 35 degrees F. At the same time large clusters of well-formed crystals were taken from the pavilion posts. During the night of January 3-4, the mirabilite crystals attached to the pier were partly dissolved; the temperature readings recorded were, maximum 37.5 degrees F., minimum 35 degrees F. I believe the critical temperature of the separation to be within a few degrees of the freezing point of fresh water.

At present there is no demand for the mirabilite, and no effort is made to gather it. Should use be found for it however, no fears as to possible insufficiency of supply need be entertained. Even though the enormous amounts cast up by the waves during the winter

months prove insufficient, the shallow water near shore could be dredged with profit; and should this fail, recourse may be had to the bed of the material already stored at a moderate depth beneath the lake bottom, and below the recently abandoned bottom now inshore.

The manufacture of sodium carbonate from the mirabilite would seemingly promise rich returns. In the time-honored and efficient Le Blanc process of carbonate preparation, sodium sulphate is first produced from common salt by an expensive treatment with sulpuric acid. That stage of the operation is accomplished by Nature in the lake and the sulphate is thrown up in lavish quantities in a manner favorable for easy collection. The limestone and the coal required for the conversion of the sulphate into carbonate are cheap and of ready access in the region; and in the sodium carbonate market Utah ought to be able to undersell most other producers.

Years ago a sodium carbonate plant was established in Salt Lake City, and an excellent product was obtained. Caustic soda and sodium hyposulphite have also been prepared from the lake water. But the high cost of railway transportation has killed this in common with many other industrial undertakings in this naturally favored region. Sooner or later, however, a market is sure to be found, and the briny waters of Utah's Dead Sea shall then yield their riches to the hand of chemic industry.

VIII.

THE GREAT BASIN.

Great Salt Lake has been mentioned as the largest water body existing in the Great Basin region, and incidentally the Great Basin has been otherwise referred to in the preceding pages. A brief consideration of geographical basins in general, and of the Great Basin in particular may prove of interest.

The term "basin" is employed by the student of earth-science to designate the area comprised in a drainage system, or that which forms a local unit of drainage as a distinct part of a drainage system. Thus the terms "basin" and "drainage area" or "drainage district" are seen to be practically synonymous. A lake basin is a depression in the crust occupied by the waters of a lake, and the expression "hydrographic basin" is applied to the region drained by a river and its tributaries, including the lake, if there be such, in which the waters collect.

In the case of rivers emptying into a lake, if the latter have an outlet the out-flowing stream and the region drained by it below the lake will be included in the hydrographic basin, and if the river reach the sea the drainage basin will extend to the shore. If however, the lake be without an outlet, as long as the loss of water by evaporation be equal to or less than the amount received, so that the lake cannot rise and find an out-

let, the hydrographic basin is spoken of as a closed, an interior, or a drainless basin.

The largest closed drainage area in North America is the Great Basin now under consideration. The region to which this name is applied is of outline roughly triangular as indicated on the map. (See plate XIV). It extends about 880 miles in greatest length running east of south and west of north, and 572 miles in extreme width from east to west. The area thus included is about 210,000 square miles, comprising the western half of Utah, the greater part of Nevada, and portions of eastern California, south-eastern Oregon, south-eastern Idaho, and south-western Wyoming. The southern part of the Great Basin has not been definitely serveyed; its approximate outline is indicated by a dotted line on the map.

The name "basin" suggests the typical form of a depression with a well-defined rim, and drainage basins are actually walled in by water-partings, which however may not be of conspicuous height. But the Great Basin is no such single depression, nor is the topography of the region suggestive of the basin structure. The area is characteristically mountainous, presenting a great number of depressions, many of them occupied by lakes; yet the region is a unit from the standpoint of drainage, for it sends no stream beyond its borders, and the removal of water from the surface is wholly due to evaporation. The central part is elevated above the

marginal portions, as was shown by the geologists of the Fortieth Parallel Exploration. Summarizing part of the excellent work done by these geologists, Gilbert says:

"The work of this corps covered a belt one hundred miles broad, spanning the Great Basin in its broadest part, and within this belt the Pleistocene lakes were studied, and for the first time approximately mapped. It was shown that the corrugated surface of the Great Basin in this latitude is higher in the middle than at the east and west margins, warranting general subdivision into the Utah Basin, the Nevada Plateau, and the Nevada Basin; that the Utah Basin formerly contained a large lake, Bonneville, extending both north and south beyond the belt of survey; that the Nevada Basin contained a similar lake, Lahontan, likewise exceeding the limits of the belt; and that the valleys of the central plateau held within the belt no less than eight small Pleistocene lakes."*

Captain Bonneville explored part of the Great Basin area in 1833, and his map, while necessarily crude and unreliable as to detail, suggests the existing conditions of interior drainage. To Fremont,† however, belongs the credit of having first clearly shown the true char-

* "Lake Bonneville," by G. K. Gilbert, p, 17. For citations made above see Geological Exploration of the 40th Parallel; Vols. I and II. Washington, 1877, 1878.

† "Report of the Exploring Expedition to the Rocky Mountains in the year 1842," etc., by Brevet-Captain J. C. Fremont. Washington, 1845.

acter of the region with respect to drainage, and by him the name "Great Basin" was first applied.

Our present knowledge of the Basin region rests on the work of Fremont just cited, and that of Stansbury in 1850, Simpson in 1859, the parties in charge of the 40th Parallel Survey and the Survey West of the 100th Meridian, and the labors of the Great Basin division of the U. S. Geological Survey as at present constituted.

A glance at the map shows that the closed area of the Basin is bounded by the drainage district of the Columbia river on the north, by Colorado river drainage on the east, and by Pacific drainage on the west. While this is by far the largest closed drainage basin in North America, eight times greater indeed than the estimated area of all other closed basins of the United States combined, it must be remembered that "North America as compared with other continents is not characterized by interior drainage. According to data compiled by Murray, the closed basins in Australia aggregate 52 per cent of its area, those of Africa 31 per cent, of Eurasia 28 per cent, of South America 7.2 per cent, of North America 3.2 per cent. The Great Basin is great only in comparison with similar districts of our own continent. The interior district of the Argentine Republic is half as large again, and that of central Australia exceeds the Great Basin seven times. Sahara exceeds

it sixteen times, and the interior district of Asia twenty-three times."*

Most of the existing lakes within the Basin area are alkaline or salt; though a few having outlets to lower levels are fresh. Among the fresh water-bodies are Utah Lake, which sends the Jordan River to Great Salt Lake; Bear Lake discharging through Bear River into Salt Lake, and Lake Tahoe, the "gem of the Sierras," which overflows through Truckee canyon into Pyramid and Winnemucca lakes, 2,400 feet below. Among the salt and alkaline lakes of the Basin are Great Salt Lake and Sevier Lake in Utah; Soda, Walker, Winnemucca, and Pyramid Lakes in Nevada; Albert Lake, Oregon, Mono Lake and Owen's Lake, California.

The term "saline lakes" is used in a generic sense and includes both salt and alkaline lakes. There are two principal ways by which saline lakes may be formed:— (1.) By the isolation of a part of the sea, as for example by the cutting off of bays, or by the elevation of a portion of the ocean floor, carrying up sea-water in the depressions. (2.) By the accumulation of river or spring water in depressions without outlet, with concentration of the water by evaporation. Lakes resulting from the first process may be said to be of

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* "Lake Bonneville;" p. 12. For citations from Murray see Scottish Geog. Mag. vol. III, pp. 65-77.

oceanic origin; then those of the other class are of terrestrial origin.

Saline lakes of oceanic origin are of necessity salt; those of the terrestrial type are salt or alkaline according to the predominating minerals washed from the rocks and accumulated by evaporation. Alkaline chlorides produce salt lakes, and alkaline carbonates result in alkaline lakes. Alkaline lakes are relatively rare, though notable occurrences of the sort characterize the Great Basin. The California lakes, Mono and Owen, are perhaps the best examples; they both contain considerable quantities of sodium carbonate together with other carbonates and some salt. Borax lakes also occur in California and Nevada.

But whatever may be the nature of the dissolved solids, the lake will not become saline unless it is entirely enclosed, so that its loss of water by evaporation exceeds its supply. Should the water supply of a saline lake increase, as by climatic changes, the lake will rise, and if the process continue will find an outlet and in time be rinsed out, thus becoming a fresh-water body.

The aridity of the Great Basin is a matter of general knowledge. The subject is thus stated by comparison and estimate by Gilbert:—* "On the broad plain bounded east and west by the Appalachian Mountains and the Mississippi River, 43 inches of rain falls in a year. On the lowlands of the Great Basin there

* "Lake Bonneville," p. 6-7.

falls but 7 inches. In the former region the average moisture content of the air is 69 per cent of that necessary for saturation; in the lowlands of the Great Basin it is 45 per cent. From the surface of Lake Michigan evaporation removes each year a layer of water 22 inches deep. The writer has estimated that 80 inches are yearly thus removed from Great Salt Lake, and Mr. Thomas Russell has computed from annual means of temperature, vapor tension, and wind velocity, that in the lowlands of the Great Basin the annual rate of evaporation from water surfaces ranges from 60 inches at the north to 150 inches at the south."

No sketch of the Great Basin would be complete without some reference to the peculiar mountain structure of the region. Geographical maps show that the mountainous character predominates from the Wasatch to the Sierra. The ranges within the Basin are short, and strikingly uniform in their general trend north and south. The structure of these mountain ranges is so different from the usual order, and so characteristic of this particular region, that mountains of the kind wherever found are to be classed as belonging to the Basin Range type.

Ordinary mountain ranges consist essentially of stratified rocks, the strata of which have been crushed and crumpled by lateral pressure, so as to appear in sec-

tion as complicated folds. Anticlinal arches and synclinal troughs follow each other in close or more open folds according to the degree of compression. Such mountain ranges were originally sea sediments, and their situation marks old marginal sea-bottoms. This, the common mountain structure, is spoken of as the anticlinal type.

But the Basin ranges are of monoclinal structure, —as if great crust blocks had been tilted on edge. One face of a mononclinal ridge is relatively steep,it is in fact the rough face of the crust block which has been broken by faulting; the other slope is gentler, following in general the dip of the upturned beds. Mononclinal mountain masses result from tension by which the crust is broken up into great blocks.

Of the origin of the Basin ranges, and of the Wasatch and Sierra mountains which virtually form the walls of the Basin, Le Conte* writes: "The Sierra received its present form and altitude by the upheaving on its eastern side of a great mountain block—300 miles long and 50 to 70 miles wide—forming there a normal fault, with a displacement of probably not less than 15,000 feet. * * * On the other boundary of the Basin region the Wasatch was at the same time also heaved up on its western side, forming there one of the

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*Elements of Geology, 4th ed., p. 277. See also American Journal of Science, Vol. 33, p. 262 for an article by the same author.

greatest faults known. [40,000 feet displacement according to King.] * * * The whole Basin region, including the Sierra on one side and the Wasatch on the other, was lifted, probably by intumescent lavas, into an arch, and by tension split into great oblong crust blocks. The arch broke down, the crust blocks re-adjusted themselves to form the Basin ranges, and left the abutments, viz, the Sierra and the Wasatch, with their raw faces looking toward one another across the intervening Basin. It must not be imagined, however, that this took place at once as a great cataclysm, but rather that it took place very slowly—the lifting, the breaking down, and the re-adjustment, all going on at the same time."

In some of the depressions between these displaced crust blocks water has accumulated and thus have the lakes of the Great Basin been formed. Other depressions, the receptacles of but limited drainage may hold water for a short period only immediately after a rainy season or following the heavy storms known as cloudbursts; such ephemeral water bodies are called playa-lakes.

IX.

THE ANCIENT LAKE—LAKE BONNEVILLE.

That the Great Salt Lake is a remnant of a larger body of water which once filled the entire valley and extended beyond the valley walls to the north, south, and west, is apparent to even the unscientific observer. Yet our knowledge of this ancient water body has been accumulated but gradually, and many investigators and observers have contributed thereto.

Capt. Fremont in 1842 recorded the occurrence of a line of drift-wood observed by him a few feet above the level of the existing lake; and in this he read the indications of variation in level at that time recent, but he made no record of the grander phenomena of ancient shore lines on the adjacent mountains.

Capt. Howard Stansbury, whose valuable labors in connection with the survey of Great Salt Lake in 1849-1850, have been mentioned, observed the lines of early shore action, and inferred therefrom the former existence of a great lake or sea. Referring to a particular plain near Lakeside on the line of the Southern Pacific railway, he wrote:

"This extensive flat appears to have formed at one time the northern portion of the lake, for it is now but slightly above its present level. Upon the slope of a ridge connected with this plain, thirteen distinct succes-

sive benches, or water marks, were counted, which had evidently at one time been washed by the lake, and must have been the result of its action continued for some time at each level. The highest of these is now about two hundred feet above the valley which has itself been left by the lake, owing probably to gradual elevation occasioned by subterraneous causes. If this supposition be correct, and all appearances conspire to support it, there must have been here at some former period a vast inland sea, extending for hundreds of miles; and the isolated mountains which now tower from the flats, forming its western and southwestern shores, were doubtless huge islands similar to those which now rise from the diminished waters of the lake."*

In 1852 Lieut. E. G. Beckwith visited portions of the Great Basin in charge of a government expedition. He was impressed by the distinctness of the old beach lines, and correctly concluded that the Salt Lake had stood at a higher level. He says:

"The old shore lines existing in the vicinity of the Great Salt Lake present an interesting study. Some of them are elevated but a few feet (from five to twenty) above the present level of the lake, and are as distinct and as well defined and preserved as its present beaches; and Stansbury speaks, in the Report of his exploration, pages 158, 160, of drift wood still existing upon those

* "Exploration and Survey of the Valley of the Great Salt Lake of Utah," etc., by Howard Stansbury. Philadelphia. 1852, p. 105.

having an elevation of five feet above the lake, which unmistakably indicates the remarkably recent recession of the waters which formed them, whilst their magnitude and smoothly-worn forms as unmistakably indicate the levels which the waters maintained, at their respective formations for very considerable periods.

"In the Tuilla [Tooele] Valley at the south end of the lake, they are so remarkably distinct and peculiar in form and position that one of them, on which we traveled in crossing that valley on the 7th of May, attracted the observation of the least informed teamsters of our party—to whom it appeared artificial. Its elevation we judged to be twenty feet above the present level of the lake. It is also twelve or fifteen feet above the plain to the south of it, and is several miles long; but it is narrow, only affording a fine road-way, and is crescent-formed, and terminates to the west as though it had once formed a cape, projecting into the lake from the mountains on the east—in miniature, perhaps, not unlike the strip of land dividing the sea of Azoff from the Putrid Sea. From this beach the Tuilla [Tooele] Valley ascends gradually towards the south, and in a few miles becomes partly blocked up by a cross-range of mountains with passages at either end however, leading over quite as remarkable beaches, into what is known to the Mormons as Rush Valley, in which there are still small lakes or ponds, once, doubtless, forming part of the Great Salt Lake.

"The recessions of the waters of the lake from the beaches at these comparatively slight elevations, took place beyond all doubt, within a very modern geological period; and the volume of the water of the lake at each subsidence—by whatever cause produced, and whether by gradual or spasmodic action— seems as plainly to have been diminished; for its present volume is not sufficient to form a lake of even two or three feet in depth over the area indicated by these shores, and, if existing, would be annually dried up during the summer.

* * * * * * *

"But high above these diminutive banks of recent date, on the mountains to the east, south, and west, and on the islands of the Great Salt Lake, formations are seen, preserving, apparently, a uniform elevation as far as the eye can extend,—formations on a magnificent scale, which, hastily examined, seem no less unmistakably than the former to indicate their shore origin. They are elevated from two or three hundred to six or eight hundred feet above the present lake; and if upon a thorough examination they prove to be ancient shores, they will perhaps afford (being easily traced on the numerous mountains of the Basin) the means of determining the character of the sea by which they were formed," etc.*

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* Lieut. E. G. Beckwith, in Pacific Railroad reports, vol. 2, p, 67: Washington, 1855,

Observations were accumulated by Blake, Simpson and his assistant, Englemann, by King, Hague, Emmons, Hayden, Bradley, Poole, Peale, and others, all increasing our stock of information regarding the ancient lakes of the Great Basin, and bearing more or less directly on the early history of what is now the Great Salt Lake.* But it is to Grove Karl Gilbert and his associates to whom we owe the greater part of our present knowledge of the Great Salt Lake and its geological history. His report, forming the first volume of the U. S. Geological Survey monographs, is the standard work on the subject.

Careful examination furnishes evidence at once abundant and conclusive that this ancient lake extended southward over the Sevier Desert, and probably over the Escalante Desert also, nearly to the Arizona line; westward over the Great Desert, into Nevada; and northward to the upper limit of Cache valley and therefore 25 miles beyond the Idaho boundary. It formed the largest of the many flooded Pleistocene lakes of the Basin region. In 1876, Gilbert named this inland sea Lake Bonneville, in honor of Captain Bonneville, who gave the first authentic description of the existing lake as a result of his explorations in 1833, and after whom Washington Irving endeavored to establish the name "Lake Bonne-

* For an excellent summary of investigations on the past of the Great Salt Lake, see "Lake Bonneville," pp. 12-19.

ville" as the designation of the existing Great Salt Lake.

When at its highest level, Lake Bonneville had an extreme north and south length of 300 miles, a greatest east and west extent of 180 miles; it presented an area of 19,750 square miles. The lake reached from 42 degrees 30 minutes to 37 degrees 30 minutes north latitude, and was divided almost equally by the line of 113 degrees west longitude.

The Great Salt Lake, while it is the largest and most important, is not the only existing fragment of Lake Bonneville. Utah and Sevier lakes remain, occupying the lowest parts of their separate valleys to the south. Lake Utah is a body of fresh water with 127 square miles surface; it sends its overflow through the Jordan River northward to the Great Salt Lake. Sevier Lake is a saline body of variable dimensions, attaining during humid seasons a considerable area. In 1872, it covered 188 square miles; while in dry times it practically evaporates away, leaving a crystalline residuum of impure sodium chloride and sulphate five inches in depth, to mark the lowest part of its site.

The principal divisions of Lake Bonneville were: (1) The main body, comprising the area of the existing lake and that of the Salt Lake Desert; (2) Cache bay to the north; (3) Sevier bay, and (4) Escalante bay, to the

south. The names used are identical with the existing geographical designations. These parts of the great lake were defined by peninsulas and archipelagos, which appear today as hills and mountain spurs, while the connecting straits are represented by valley passes. These facts are shown on the accompanying map. Some of the hills rising from the plain, which constitutes the Salt Lake Desert, have their bases deeply buried beneath lake sediments; they rise from the land level as abruptly as the islands of the present lake above the water, and the popular names by which they are known, designate them as islands still. (See plate XIX.)

The shore lines appearing upon the mountain sides against which the ancient waters beat, are, throughout the greater part of their extent, so distinct that even the school boy is led to think of them as old water margins. Along these terraces abundant proofs of littoral structure may be found. In places pebbly beaches tell of lapping waves, while the covering and cementing tufa attached to the worn stones testifies to chemical precipitation or deposit by evaporation. Ripple marks are as clearly shown in the sandstones and hardened clays as on the shores which are at present washed by the briny waters. Embankments, wave-cut caves, and all the other usual phenomena of littoral action exist in a state of impressive perfection. In many places, especially along

the eastern margin, where the waters beat against the face of the Wasatch mountains, the lines have suffered extensive deformation through fault disturbances; indeed, in the immediate neighborhood of Salt Lake City, the fault scarp is so fresh as to still present the rough face of recent fracture.

The work of stream erosion is apparent in the transverse gashing of the shore terraces; this and the erosive action of atmospheric agencies are operating toward a general degradation of the terrace structure. These destructive processes, however, have not as yet been able to hide, or even to seriously disfigure the evidence of former conditions. The map of Lake Bonneville can be drawn with as great an assurance of accuracy as attends the charting of any existing water body. (See plate XV.)

Each shore line indicates, of course, a practically constant level of the lake during a considerable length of time, or a periodical return to the same level at short intervals during a long cycle of years. There is, however, little evidence of interruption in the process of shore sculpture, and a constancy of level rather than a return of the water to the same height at each of the stages marked by a shore line is indicated. On the Oquirrh mountains bounding the Salt Lake valley on the west, ten distinct lines have been counted, sketched, and photographed by the writer; but here, as indeed all along the old shore margin, three principal levels appear and a

fourth is seen with great distinctness on one of the large islands of the lake. These have been designated as follows:

1. The Bonneville shore line, the highest and most conspicuous; this is at a height of 1,000 feet above the present mean level of the water.

2. Provo shore line, 375 feet below the Bonneville. This was named by Howell from the great size and perfection of the delta constructed at this level by the Provo River as it enters Utah valley from the canyon.

3. Intermediate shore lines, between the Bonneville and the Provo. These lines show a series of fluctuations in lake level each of comparatively short duration. While the embankments are large they are devoid of great sea cliffs and caves such as characterize the Bonneville and the Provo. On Stansbury Island, one of the largest bodies of land rising from the waters of the Salt Lake, a lower level has left a clearly defined terrace, 300 feet above the present water surface; this has been called:

4. Stansbury shore line.

The chronological order of the principal shore line formation is as follows: 1. Intermediate; 2. Bonneville; 3. Provo; 4. Stansbury. While the Bonneville level is the highest and most conspicuous of the shore terraces, it marks a shorter duration of constant level than does the Provo. It is in fact the most conspicuous because it is the highest, deriving its prominence from

its clearly defined contrast with the features of sub-aerial topography immediately above it. (See plate XVIII.)

Years prior to the discovery of any outlet through which the great lake could have discharged its surplus waters, the existence of such an escape channel was predicted. Gilbert declared (1) that the Bonneville shore lines would be found to have been determined by an overflow of lake water, and (2) that the Provo line would be traceable to a similar determining cause.* Writing in 1890 he says: "The first of these predictions has been verified in its letter, but not in its spirit; the second has proved to have full warrant. My anticipation was based on the following consideration: A lake without overflow has its extent determined by the ratio of precipitation to evaporation within its basin; and since this ratio is inconstant, fluctuating from year to year and from decade to decade, it is highly improbable that the water level will remain constant long enough to permit its waves to carve a deep record. I failed to take account of the fact that the highest shore-mark of the series is conspicuous by reason of the contrast there exhibited between land sculpture and littoral sculpture. We know that the height of the Bonneville shore-line was determined in a certain sense by overflow, since a discharge limited the rise of the water; but the

* Exploration West of the 100th Meridian, III., p, 90.

carving of the shore was essentially completed before the discharge, and as soon as that began the water fell. At the Provo horizon, on the contrary, a constant or nearly constant water-level was maintained by discharge for a long time." *

The search for the Bonneville outlet was prosecuted with the assurance that such a channel existed. A number of passes were found but slightly above the required level, and indeed "a difference of only a few feet determined the actual point of discharge." On the northern rim of Cache valley at Red Rock Pass, near Oxford, Idaho, the outlet channel was discovered. The topographical features and the erosion record were so distinct as to place the question of the source of Bonneville River practically beyond doubt. The honor of this discovery is accorded to Gilbert, though Peale has disputed Gilbert's rights of priority on the basis of Bradley's suggestion, made in 1872.† Bonneville River flowed through Marsh Valley, being joined in this part of its course by the Portneuf. The combined streams then followed Portneuf Pass to Snake River, thence to the Columbia. Above its junction with the Portneuf the Bonneville River must have equalled and possibly exceeded in size the Niagara. Regarding the duration of the river's existence Gilbert says:

* Lake Bonneville, p. 171.

† American Journal of Science, June, 1878.

"How long the discharging river maintained its colossal dimensions can not be learned, but the period certainly was not great. The entire prism of water between Bonneville and Provo planes would be discharged by the Niagara channel in less than twenty-five years; and if the Bonneville River reached a greater size, it would have maintained it only for a shorter time."*

Alluvial fans and deltas exist at the mouths of canyons opening into the valley. Of the fans or cones, some were constructed prior to the Bonneville epoch, while others show by the absence of shore lines and lake sediments that they are more recent than the high water marks. A typical alluvial cone of large dimensions occurs at the base of a prominent spur of the Wasatch range a mile north of Salt Lake City. This cone derives additional interest from the fact that its surface shows the course of a well developed fault scarp. In Salt Lake valley and elsewhere the alluvial cones formed by the streams issuing from canyon openings at short intervals coalesce and present the appearance of almost continuous terraces. In such cases the existing stream reveals a section of the deposit, a study of which, together with an examination of the slope and general configuration will enable the observer to distinguish be-

* "Lake Bonneville," p. 177,

tween the cone formation on the one hand and the lake terrace and delta on the other.

The existence of deltas along the old lake shores was pointed out by Bradley in 1872;* but it remained for Howell and Gilbert to give the subject full and careful study. While in places delta formations are preserved at the Bonneville level, the best and largest belong to the Provo stage. The streams following the receding lake would indeed destroy much of their own delta construction at higher levels and earlier periods. However, at some places the delta structure presents a record of Intermediate, Bonneville, and Provo stages complete. Following the American Fork river from the canyon toward the mouth of the stream in Utah Lake,the observer may read the history of delta formation and destruction with comparative ease. As revealed by the stream-made section the Bonneville delta shows a height of 120 feet at its outer margin, and a radius of over 4,800 feet. The Intermediate delta being the first formed, was partly covered by the later Bonneville; both were cut through by the stream as the lake fell to the Provo level, and the material so removed was built into a still younger delta.

The deltas of the Logan river form a series of sloping terraces extending downward from the mountain face. Each delta indicates the partial destruction of earlier depositions above. In Salt Lake valley, the delta formed

* "Geological Survey of the Territories," 1872, p. 192.

by City Creek (the main source of the water supply for Salt Lake City today), reveals itself as high benches through which the stream has kept for itself a passage. Wave-action appears to have been unusually strong at this place, and consequently the typical delta form is considerably modified. The delta constructed by the Provo river in Utah valley, covers over 20,000 acres, and another occurs a few miles to the south—the work of the Spanish Fork stream—with an area of 8,000 acres.

The occurrence of calcium carbonate, usually as calcareous tufa, is common to the shores of most of the Great Basin lakes. The extensive accumulation of this material in Lake Lahontan has received due attention from King and Russell.* In Lake Bonneville, however, the deposition has taken place on a small scale only. Where this material occurs at all it is found as an incrustation on the faces of cliffs, or as a cement coating the pebbles and forming them into a coherent conglomerate. None of the calcareous deposit is found in spots which once were quiet coves or bays; while the largest quantities occur where the waves must have produced the strongest surf action. It has been suggested that the aeration of the water probably promoted the precipitation of the calcium carbonate, and that the particles coalesced at

* "Exploration of the 40th Parallel, I., p. 514."

the instant of separation.* In the open lake the deposition of calcium carbonate went on in the usual manner, the particles remaining separate and forming an ordinary sediment. None of the Thinolite, named and described by King in connection with Lahontan and Mono lakes, has thus far been found within the Bonneville district.

That the diminution of lake volume from the height of the Provo line to the present level, is due to desiccation and not to a process of emptying by overflow, is shown by the absence of any break or notch in the rim below the level of the shore named, through which the water could have found an outlet, and from the deposits of mineral matter in the lake floor. In the parts recently vacated by the receding waters, the saline matters effloresce upon the soil during dry seasons, and disappear in times of abundant precipitation. Careful analyses of these substances show marked correspondence with the mineral contents of today. As the retreating waters divided the lake into separate areas, each lakelet proceeded in the process of desiccation according to its own relative conditions of supply and evaporation.

In some parts, particularly in the region of the old Sevier body of Lake Bonneville, deposits of gypsum are found. These may not be the effect of any chemical de-

* "Lake Bonneville," p. 169.

position; as Gilbert suggests, they may be the result of evaporation of water that had derived the material by simple solution from the rocks. The gypsum is occasionally found in the form of small free crystals, and as in the Sevier desert, these may be drifted by wind action into glistening dunes. The author of the monograph on Lake Bonneville says:

"Perhaps no gypsum deposit in the world is so easily exploited as this; it needs merely to be shoveled into wagons and hauled away. Mr. Russell estimates that the dunes contain about 450,000 tons, and a much larger amount can be obtained from the playa."*

While the exposure of an extensive series of formations and systems of rocks is made visible by the orogenic disturbances which have resulted in the elevation of the Wasatch and contiguous ranges, these aid us but little in determining the time of the Bonneville epoch or the age of the lake beds. In the lake floor, however, fairly conclusive evidence as to the true geological age may be found. Tertiary strata of well determined age exist within the Bonneville basin and in places these are found unconformably overlaid by the lake sediments. The Tertiary deposits, while presenting a wide variety of texture, are quite readily distinguishable from the

*"Lake Bonneville, p.223."

later lacustrine beds by lithological character and by their disturbed positions. It is evident therefore that the lake deposits are post-Tertiary. Moreover the "Bonneville beds are thus seen to be the latest lacustrine deposit of the basin, and this fact indicates their synchronism with the latest littoral evidence of a lacustrine condition."

Over the valley surface the beds are practically undisturbed; in some parts they rise by gentle slopes almost to the level of the shore lines. Gilbert has carefully studied the section exposed along the old river bed, running northwest from the Sevier desert, between McDowell and Simpson mountains to the Salt Lake desert, and this he announces as almost a typical section.* Through this channel a stream connected Sevier Lake with the larger Salt Lake, after the division of Lake Bonneville into separate bodies in its shrinkage course. This river existed in post-Provo times, for the shore lines extend along the bordering hillsides, the Bonneville line being fully 700 feet above the highest banks of the channel. Gilbert states that his exploration "demonstrated that the entire site of the channel was submerged during both Bonneville and Provo epochs." The channel walls of the old river bed reveal the following members in ascending order:

1. Yellow clay with local dashes of sand sedi-

* "Lake Bonneville," p. 190.

ment and nodular aggregates of selenite crystals. Of this a depth of ninety feet is exposed, but the bottom has not been reached.

2. White marl, a layer ten feet in thickness, overlying the yellow clay, on an eroded surface. The lower layers of the marl contain shells of nearly the same species as occur in the clay below.

3. Free sand; a top layer grading without break of continuity into the marl below; an average thickness of ten feet is recorded. This succession of beds is less distinct on the slopes and particularly so near the shore lines where the true sedimentary deposits are mixed with littoral material. The eroded surface of the yellow clay indicates a break in the process of lake deposition, and this interruption is further shown by the alluvial deposits and all the proofs of sub-aerial erosion between the yellow clay and the white marl. It is evident therefore that there are two distinct flood times in the Bonneville history, two periods of greatest operation of lacustrine agencies separated by a perior of dryness. The second of these periods was probably not more than one-fifth of the duration of the first. Gilbert sums up the evidence on the subject as follows:*

"Then followed two epochs of high water, with an interval during which the basin was nearly or quite empty. The first of these epochs was at least five times

* "Lake Bonneville," p. 317.

as long as the second. The second scored its water mark ninety feet higher than the first, and would have encroached still farther on the basin sides had it not been checked by outflow. During the epoch of outflow, the discharging current eroded the rim, and thus lowered the lake 375 feet; and after the outflow had ceased, the water fell by desiccation, with one notable interruption, to its present level in Great Salt Lake. The inter-Bonneville epoch of low water was of greater duration than the time that had elapsed since the final desiccation."

A similar dual flooding has been demonstrated by the labors of King and Russell in the region of Lake Lahontan, a body of water which may be regarded as a twin sister to Lake Bonneville.*

The correlation of these periods of maximum flooding with the prime divisions of the Glacial Epoch has been established with considerable certainty. The evidence points to periods of low temperature corresponding with the times of greatest water surface. Low temperature with consequent decrease of loss by evaporation is an important factor, if not indeed, the most effective among the causes which determined the successive maxima of Lake Bonneville and its related water bodies in the Basin.

The fossils, particularly the fresh water shells, testify to unfavorable conditions of growth. They are few

* "Exploration of the 40th Parallel," I., p. 524.

and in the individuals are dwarfed, as would be expected of species struggling for life under the rigors of a glacial climate. Quoting again:*

"In the case of Lake Lahontan, and in the case of the first Lake Bonneville, the unfavorable condition may possibly have been impurity of water, but the second Lake Bonneville was freshened by outflow, and the dwarfing of its mollusks is best explained by low temperature. * * * These phenomena sustain the theory that the Pleistocene lakes of the western United States were coincident with the Pleistocene glaciers of the same district, and were produced by the same climatic changes. It follows as a corollary that the glacial history of this region was bipartite, two maxima of glaciation being separated, not by a mere variation in intensity, but by a cessation of glaciation."

Well-defined ice deposits occur in a few places along the old shore, below the high water marks. One of the best examples is found at the mouth of Little Cottonwood Canyon but a few miles south of Salt Lake City (See plates XXI) Emmons first directed attention to the fact that the glacier here referred to deposited its moraines within the Bonneville area. † The south lateral moraine is well preserved; the other has lost its typical form, prob-

* "Lake Bonneville, p. 318."

† "Exploration of the 40th Parallel," II., p. 354.

ably through an expansion or a change of direction of the glacier whereby the north moraine was disfigured. The moraine material is traceable downward from the canyon gateway for a full mile upon the plain, and in its lower parts it is covered by alluvium to a depth of sixty-five feet at least, and by a lacustrine deposit of sand. The glacier existed during a period of high water—probably that of the Provo shore line.

Major Powell presents a summary of the labors of his associates on Bonneville history in this concise way:*

"First, the waters were low, occupying, as Great Salt Lake now does, only a limited portion of the bottom of the basin. Then they gradually rose and spread, forming an inland sea, nearly equal to Lake Huron in extent, with a maximum depth of 1,000 feet. Then the waters fell, and the lake not merely dwindled in size, but absolutely disappeared, leaving a plain even more desolate than the Great Salt Lake Desert of today. Then they again rose, surpassing even their former height, and eventually overflowing the basin at its northern edge, sending a tributary stream to the Columbia River; and, last, there was a second recession, and the waters shrunk away, until now only Great Salt Lake and two smaller lakes remain."

* U. S. Geological Survey, report for 1880-81, p. xvii.

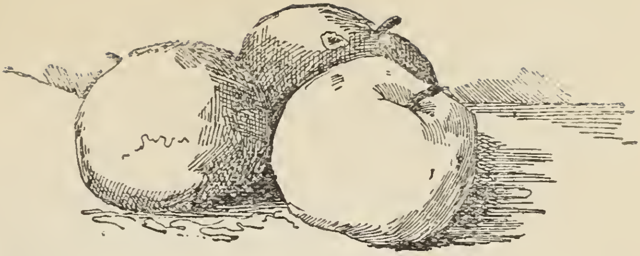
Young Folk's Library of Choice Literature

THE THREE GOLDEN APPLES.

BY

NATHANIEL HAWTHORNE.

EDUCATIONAL PUBLISHING COMPANY
BOSTON
NEW YORK CHICAGO SAN FRANCISCO



The Three Golden Apples.

Did you ever hear of the golden apples, that grew in the garden of the Hesperides? Ah, those were such apples as would bring a great price, by the bushel, if any of them could be found growing in the orchards of now-a-days! But there is not, I suppose, a graft of that wonderful fruit on a single tree in the wide world. Not so much as a seed of those apples exists any longer.

And, even in the old, old, half-forgotten times, before the garden of the Hesperides was overrun with weeds, a great many people doubted whether there could be real trees that bore apples of solid gold upon their branches. All had heard of them, but nobody remembered to have seen any. Children, nevertheless, used to listen, open-mouthed, to

stories of the golden apple-tree, and resolved to discover it, when they should be big enough. Adventurous young men, who desired to do a braver thing than any of their fellows, set out in quest of this fruit. Many of them returned no more; none of them brought back the apples. No wonder that they found it impossible to gather them! It is said that there was a dragon beneath the tree, with a hundred terrible heads, fifty of which were always on the watch, while the other fifty slept.

In my opinion, it was hardly worth running so much risk for the sake of a solid golden apple. Had the apples been sweet, mellow, and juicy, indeed, that would be another matter. There might then have been some sense in trying to get at them, in spite of the hundred-headed dragon.

But, as I have already told you, it was quite a common thing with young persons, when tired of two much peace and rest, to go in search of the garden of the Hesperides. And once the adventure was undertaken by a hero who had enjoyed very little peace or rest since he came into the world. At the time of which I am going to speak, he was wandering through the pleasant land of Italy, with a mighty club in his hand, and a bow and quiver slung across his shoulders. He was wrapt in the skin of the biggest and fiercest lion that ever had been seen, and which he himself had killed; and though, on the whole, he was kind, and generous, and noble, there was a good deal of the lion's fierceness in his heart. As he went on his way, he

continually inquired whether that were the right road to the famous garden. But none of the country people knew anything about the matter, and many looked as if they would have laughed at the question, if the stranger had not carried so very big a club.

So he journeyed on and on, still making the same inquiry, until, at last, he came to the brink of a river, where some beautiful young women sat twining wreaths of flowers.

"Can you tell me, pretty maidens," asked the stranger, "whether this is the right way to the garden of the Hesperides?" Ahem

The young women had been having a fine time together, weaving the flowers into wreaths, and crowning one another's heads. And there seemed to be a kind of magic in the touch of their fingers, that made the flowers more fresh and dewy, and of brighter hues, and sweeter fragrance, while they played with them, than even when they had been growing on their native stems. But, on hearing the stranger's question, they dropped all their flowers on the grass, and gazed at him with astonishment.

"The garden of the Hesperides!" cried one. "We thought mortals had been weary of seeking it, after so many disappointments. And pray, adventurous traveler, what do you want there?"

"A certain king, who is my cousin," replied he, "has ordered me to get him three of the golden apples."

"Most of the young men who go in quest of these

apples," observed another of the damsels, "desire to obtain them for themselves, or to present them to some fair maiden whom they love. Do you, then, love this king, your cousin, so very much?"

"Perhaps not," replied the stranger, sighing. "He has often been severe and cruel to me. But it is my destiny to obey him."

"And do you know," asked the damsel who had first spoken, "that a terrible dragon, with a hundred heads, keeps watch under the golden apple-tree?"

"I know it well," answered the stranger, calmly. "But, from my cradle upward, it has been my business, and almost my pastime, to deal with serpents and dragons."

The young women looked at his massive club, and at the shaggy lion's skin which he wore, and likewise at his heroic limbs and figure; and they whispered to each other that the stranger appeared to be one who might reasonably expect to perform deeds far beyond the might of other men. But, then, the dragon with a hundred heads! What mortal, even if he possessed a hundred lives, could hope to escape the fangs of such a monster? So kind-hearted were the maidens, that they could not bear to see this brave and handsome traveler attempt what was so very dangerous, and devote himself, most probably, to become a meal for the dragon's hundred ravenous mouths.

"Go back," cried they all, "go back to your own home! Your mother, beholding you safe and sound, will shed tears

of joy; and what can she do more, should you win ever so great a victory! No matter for the golden apples! No matter for the king, your cruel cousin! We do not wish the dragon with the hundred heads to eat you up!"

The stranger seemed to grow impatient at these remonstrances. He carelessly lifted his mighty club, and let it fall upon a rock that lay half-buried in the earth, near by. With the force of that idle blow, the great rock was shattered all to pieces. It cost the stranger no more effort to achieve this feat of a giant's strength than for one of the young maidens to touch her sister's rosy cheek with a flower.

"Do you not believe," said he, looking at the damsels with a smile, "that such a blow would have crushed one of the dragon's hundred heads?"

Then he sat down on the grass, and told them the story of his life, or as much of it as he could remember, from the day when he was first cradled in a warrior's brazen shield. While he lay there, two immense serpents came gliding over the floor, and opened their hideous jaws to devour him; and he, a baby of a few months old, had griped one of the fierce snakes in each of his little fists, and strangled them to death. When he was but a stripling, he had killed a huge lion, almost as big as the one whose vast and shaggy hide he now wore upon his shoulders. The next thing that he had done was to fight a battle with an ugly sort of monster, called a hydra, which had no less than nine heads, and exceedingly sharp teeth in every one of them.

"But the dragon of the Hesperides, you know," observed one of the damsels, "has a hundred heads!"

"Nevertheless," replied the stranger, "I would rather fight two such dragons than a single hydra. For, as fast as I cut off a head, two others grew in its place; and, besides, there was one of the heads that could not possibly be killed, but kept biting as fiercely as ever, long after it was cut off. So I was forced to bury it under a stone, where it is doubtless alive, to this very day. But the hydra's body, and its eight other heads, will never do any further mischief."

The damsels, judging that the story was likely to last a good while, had been preparing a repast of bread and grapes, that the stranger might refresh himself in the intervals of his talk. They took pleasure in helping him to this simple food; and, now and then, one of them would put a sweet grape between her rosy lips, lest it should make him bashful to eat alone.

The traveler proceeded to tell how he had chased a very swift stag, for a twelvemonth together, without ever stopping to take breath, and had at last caught it by the antlers, and carried it home alive. And he had fought with a very odd race of people, half horses and half men, and had put them all to death, from a sense of duty, in order that their ugly figures might never be seen any more. Besides all this, he took to himself great credit for having cleaned out a stable.

"Do you call that a wonderful exploit?" asked one of the

young maidens, with a smile. "Any clown in the country has done as much!"

"Had it been an ordinary stable," replied the stranger, "I should not have mentioned it. But this was so gigantic a task that it would have taken me all my life to perform it, if I had not luckily thought of turning the channel of a river through the stable-door. That did the business, in a very short time!"

Seeing how earnestly his fair auditors listened, he next told them how he had shot some monstrous birds, and had caught a wild bull alive, and let him go again, and had tamed a number of very wild horses, and had conquered Hippolyta, the warlike queen of the Amazons. He mentioned, likewise, that he had taken off Hippolyta's enchanted girdle, and had given it to the daughter of his cousin, the king.

"Was it the girdle of Venus," inquired the prettiest of the damsels, "which makes women beautiful?"

"No," answered the stranger. "It had formerly been the sword-belt of Mars; and it can only make the wearer valiant and courageous."

"An old sword belt!" cried the damsel, tossing her head. "Then I should not care about having it!"

"You are right," said the stranger.

Going on with his wonderful narrative, he informed the maidens that as strange an adventure as ever happened was when he fought with Geryon, the six-legged man. This

was a very odd and frightful sort of figure, as you may well believe. Any person, looking at his tracks in the sand or snow, would suppose that three sociable companions had been walking along together. On hearing his footsteps at a little distance, it was no more than reasonable to judge that several people must be coming. But it was only the strange man Geryon clattering onward, with his six legs!

Six legs, and one gigantic body! Certainly, he must have been a queer monster to look at; and, my stars, what a waste of shoe-leather!

When the stranger had finished the story of his adventures, he looked around at the attentive faces of the maidens.

"Perhaps you may have heard of me before," said he, modestly. "My name is Hercules!"

"We had already guessed it," replied the maidens; "for your wonderful deeds are known all over the world. We do not think it strange, any longer, that you should set out in quest of the golden apples of the Hesperides. Come, sisters, let us crown the hero with flowers!"

Then they flung beautiful wreaths over his stately head and mighty shoulders, so that the lion's skin was almost entirely covered with roses. They took posession of his ponderous club, and so entwined it about with the brightest, softest, and most fragrant blossoms, that not a finger's breadth of its oaken substance could be seen. It looked all like a huge bunch of flowers. Lastly, they joined hands, and danced around him, chanting words which became poetry

of their own accord, and grew into a choral song, in honor of the illustrious Hercules.

And Hercules was rejoiced, as any other hero would have been, to know that these fair young girls had heard of the valiant deeds which it had cost him so much toil and danger to achieve. But, still, he was not satisfied. He could not think that what he had already done was worthy of so much honor, while there remained any bold or difficult adventure to be undertaken.

"Dear maidens," said he, when they paused to take breath, "now that you know my name, will you not tell me how I am to reach the garden of the Hesperides?"

"Ah! must you go so soon?" they exclaimed. "You—that have performed so many wonders, and spent such a toilsome life—cannot you content yourself to repose a little while on the margin of this peaceful river?"

Hercules shook his head.

"I must depart now," said he.

"We will then give you the best directions we can," replied the damsels. "You must go to the seashore, and find out the Old One, and compel him to inform you where the golden apples are to be found."

"The Old One!" repeated Hercules, laughing at this odd name. "And, pray, who may the Old One be?"

"Why, the Old Man of the Sea, to be sure!" answered one of the damsels. "He has fifty daughters, whom some people call very beautiful: but we do not think it proper to

be acquainted with them, because they have sea-green hair, and taper away like fishes. You must talk with this Old Man of the Sea. He is a sea-faring person, and knows all about the garden of the Hesperides; for it is situated in an island which he is often in the habit of visiting."

Hercules then asked whereabouts the Old One was most likely to be met with. When the damsels had informed him, he thanked them for all their kindness,—for the bread and grapes with which they had fed him, the lovely flowers with which they had crowned him, and the songs and dances wherewith they had done him honor,—and he thanked them, most of all, for telling him the right way,—and immediately set forth upon his journey.

But, before he was out of hearing, one of the maidens called after him.

"Keep fast hold of the Old One, when you catch him!" cried she, smiling, and lifting her finger to make the caution more impressive. "Do not be astonished at anything that may happen. Only hold him fast, and he will tell you what you wish to know."

Hercules again thanked her, and pursued his way, while the maidens resumed their pleasant labor of making flower-wreaths. They talked about the hero, long after he was gone.

"We will crown him with the loveliest of our garlands," said they, "when he returns hither with the three golden apples, after slaying the dragon with a hundred heads."

Meanwhile, Hercules traveled constantly onward, over hill and dale, and through the solitary woods Sometimes he swung his club aloft, and splintered a mighty oak with a downright blow. His mind was so full of the giants and monsters with whom it was the business of his life to fight, that perhaps he mistook the great tree for a giant or a monster. And so eager was Hercules to achieve what he had undertaken, that he almost regretted to have spent so much time with the damsels, wasting idle breath upon the story of his adventures. But thus it always is with persons who are destined to perform great things. What they have already done seems less than nothing. What they have taken in hand to do seems worth toil, danger, and life itself.

Persons who happened to be passing through the forest must have been affrighted to see him smite the trees with his great club. With but a single blow, the trunk was riven as by the stroke of lightning, and the broad boughs came rustling and crashing down.

Hastening forward, without ever pausing or looking behind, he, by and by, heard the sea roaring at a distance. At this sound, he increased his speed, and soon came to a beach, where the great surf-waves tumbled themselves upon the hard sand, in a long line of snowy foam. At one end of the beach, however, there was a pleasant spot, where some green shrubbery clambered up a cliff, making its rocky face look soft and beautiful. A carpet of verdant grass, largely intermixed with sweet-smelling clover, covered the

narrow space between the bottom of the cliff and the sea. And what should Hercules espy there, but an old man, fast asleep!

But was it really and truly an old man? Certainly, at first sight, it looked very like one; but, on closer inspection, it rather seemed to be some kind of a creature that lived in the sea. For, on his legs and arms there were scales, such as fishes have; he was web-footed and web-fingered, after the fashion of a duck; and his long beard, being of a greenish tinge, had more the appearance of a tuft of sea-weed than of an ordinary beard. Have you never seen a stick of timber, that has been long tossed about by the waves, and has got all over-grown with barnacles, and, at last drifting ashore, seems to have been thrown up from the very deepest bottom of the sea? Well; the old man would have put you in mind of just such a wave-tost spar! But Hercules, the instant he set eyes on this strange figure, was convinced that it could be no other than the Old One, who was to direct him on his way.

Yes; it was the self-same Old Man of the Sea, whom the hospitable maidens had talked to him about. Thanking his stars for the lucky accident of finding the old fellow asleep, Hercules stole on tiptoe toward him, and caught him by the arm and leg.

"Tell me," cried he, before the Old One was well awake, "which is the way to the garden of the Hesperides?"

As you may easily imagine, the Old Man of the Sea awoke

in a fright. But his astonishment could hardly have been greater than was that of Hercules, the next moment. For, all of a sudden, the Old One seemed to disappear out of his grasp, and he found himself holding a stag by the fore and hind leg! But still he kept fast hold. Then the stag disappeared, and in its stead there was a sea-bird, fluttering and screaming, while Hercules clutched it by the wing and claw! But the bird could not get away. Immediately afterwards, there was an ugly three-headed dog, which growled and barked at Hercules, and snapped fiercely at the hands by which he held him! But Hercules would not let him go. In another minute, instead of the three-headed dog, what should appear but Geryon, the six-legged man-monster, kicking at Hercules with five of his legs, in order to get the remaining one at liberty! But Hercules held on. By and by, no Geryon was there, but a huge snake, like one of those which Hercules had strangled in his babyhood, only a hundred times as big; and it twisted and twined about the hero's neck and body, and threw its tail high into the air, and opened its deadly jaws as if to devour him outright; so that it was really a very terrible spectacle! But Hercules was no whit disheartened, and squeezed the great snake so tightly that he soon began to hiss with pain.

You must understand that the Old Man of the Sea, though he generally looked so much like the wave-beaten figure-head of a vessel, had the power of assuming any shape he pleased. When he found himself so roughly seized by Her-

cules, he had been in hopes of putting him into such surprise and terror, by these magical transformations, that the hero would be glad to let him go. If Hercules had relaxed his grasp, the Old One would certainly have plunged down to the very bottom of the sea, whence he would not soon have given himself the trouble of coming up, in order to answer any impertinent questions. Ninety-nine people out of a hundred, I suppose, would have been frightened out of their wits by the very first of his ugly shapes, and would have taken to their heels at once. For, one of the hardest things in this world is, to see the difference between real dangers and imaginary ones.

But as Hercules held on so stubbornly, and only squeezed the Old One so much the tighter at every change of shape, and really put him to no small torture, he finally thought it best to reappear in his own figure. So there he was again, a fishy, scaly, web-footed sort of personage, with something like a tuft of sea-weed on his chin

"Pray what do you want with me?" cried the Old One, as soon as he could take breath; for it is quite a tiresome affair to go through so many false shapes. "Why do you squeeze me so hard? Let me go, this moment, or I shall begin to consider you an extremely uncivil person!"

"My name is Hercules!" roared the mighty stranger. "And you will never get out of my clutch, until you tell me the nearest way to the garden of the Hesperides!"

When the old fellow heard who it was that had caught

him, he saw, with half an eye, that it would be necessary to tell him everything that he wanted to know. The Old One was an inhabitant of the sea, you must recollect, and roamed about everywhere, like other sea-faring people. Of course, he had often heard of the fame of Hercules, and of the wonderful things that he was constantly performing, in various parts of the earth, and how determined he always was to accomplish whatever he undertook. He therefore made no more attempts to escape, but told the hero how to find the garden of the Hesperides, and likewise warned him of many difficulties which must be overcome, before he could arrive thither.

"You must go on, thus and thus," said the Old Man of the Sea, after taking the points of the compass, "till you come in sight of a very tall giant, who holds the sky on his shoulders. And the giant, if he happens to be in good humor, will tell you exactly where the garden of the Hesperides lies."

"And if the giant happen not to be in the humor," remarked Hercules, balancing his club on the tip of his finger, "perhaps I shall find means to persuade him!"

Thanking the Old Man of the Sea and begging his pardon for having squeezed him so roughly, the hero resumed his journey. He met with a great many strange adventures, which would be well worth your hearing, if I had leisure to narrate them as minutely as they deserve.

It was in this journey, if I mistake not, that he encountered

a prodigious giant, who was so wonderfully contrived nature, that, every time he touched the earth, he became ten times as strong as ever he had been before. His name was Antæus. You may see, plainly enough, that it was a very difficult business to fight with such a fellow; for, as often as he got a knockdown blow, up he started again, stronger, fiercer, and abler to use his weapons, than if his enemy had let him alone. Thus, the harder Hercules pounded the giant with his club, the further he seemed from winning the victory. I have sometimes argued with such people, but never fought with one. The only way in which Hercules found it possible to finish the battle, was by lifting Antæus off his feet into the air, and squeezing, and squeezing, and squeezing him, until, finally, the strength was quite squeezed out of his enormous body.

When this affair was finished, Hercules continued his travels, and went to the land of Egypt, where he was taken prisoner, and would have been put to death, if he had not slain the king of the country, and made his escape. Passing through the deserts of Africa, and going as fast as he could, he arrived at last on the shore of the great ocean. And here, unless he could walk on the crests of the billows, it seemed as if his journey must needs be at an end.

Nothing was before him, save the foaming, dashing, measureless ocean. But, suddenly, as he looked toward the horizon, he saw something, a great way off, which he had not seen the moment before. It gleamed very brightly,

almost as you may have beheld the round, golden disk of the sun, when it rises or sets over the edge of the world. It evidently drew nearer; for, at every instant, this wonderful object became larger and more lustrous. At length, it had come so nigh that Hercules discovered it to be an immense cup or bowl, made either of gold or burnished brass. How it had got afloat upon the sea, is more than I can tell you. There it was, at all events, rolling on the tumultuous billows, which tossed it up and down, and heaved their foamy tops against its sides, but without ever throwing their spray over the brim.

"I have seen many giants, in my time," thought Hercules, "but never one that would need to drink his wine out of a cup like this!"

And, true enough, what a cup it must have been! It was as large—as large—but, in short, I am afraid to say how immeasurably large it was. To speak within bounds, it was ten times larger than a great mill-wheel; and, all of metal as it was, it floated over the heaving surges more lightly than an acorn-cup a-down the brook. The waves tumbled it onward, until it grazed against the shore, within a short distance of the spot where Hercules was standing.

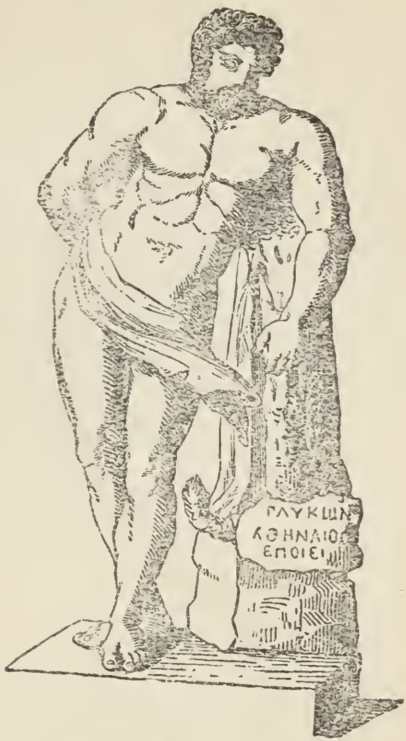
As soon as this happened, he knew what was to be done; for he had not gone through so many remarkable adventures without learning pretty well how to conduct himself, whenever anything came to pass a little out of the common rule. It was just as clear as daylight that this marvelous cup had

been set adrift by some unseen power, and guided hitherward, in order to carry Hercules across the sea, on his way to the garden of the Hesperides. Accordingly, without a moment's delay, he clambered over the brim, and slid down on the inside, where, spreading out his lion's skin, he proceeded to take a little repose. He had scarcely rested, until now, since he bade farewell to the damsels on the margin of the river. The waves dashed, with a pleasant and ringing sound, against the circumference of the hollow cup; it rocked lightly to and fro, and the motion was so soothing that it speedily rocked Hercules into an agreeable slumber.

His nap had probably lasted a good while, when the cup chanced to graze against a rock, and, in consequence, immediately resounded and reverberated through its golden or brazen substance, a hundred times as loudly as ever you heard a church-bell. The noise awoke Hercules, who instantly started up and gazed around him, wondering whereabouts he was. He was not long in discovering that the cup had floated across a great part of the sea, and was approaching the shore of what seemed to be an island. And, on that island what do you think he saw?

No; you will never guess it, not if you were to try fifty thousand times! It positively appears to me that this was the most marvelous spectacle that had ever been seen by Hercules, in the whole course of his wonderful travels and adventures. It was a greater marvel than the hydra with nine heads, which kept growing twice as fast as they were

cut off; greater than the six-legged man-monster; greater than Antæus; greater than anything that was ever beheld by anybody, before or since the days of Hercules, or than anything that remains to be beheld by travelers in all time to come. It was a giant!



STATUE OF HERCULES.

But such an intolerably big giant! A giant as tall as a mountain; so vast a giant, that the clouds rested about his midst, like a girdle, and hung like a hoary beard from his chin, and flitted before his huge eyes, so that he could neither see Hercules nor the golden cup in which he was voyaging. And most wonderful of all, the giant held up

his great hands and appeared to support the sky, which, so far as Hercules could discern through the clouds, was resting upon his head! This does really seem almost too much to believe.

Meanwhile, the bright cup continued to float onward, and finally touched the strand. Just then a breeze wafted away the clouds from before the giant's visage, and Hercules beheld it, with all its enormous features; eyes each of them as big as yonder lake, a nose a mile long, and a mouth of the same width. It was a countenance terrible from its enormity of size, but disconsolate and weary, even as you may see the faces of many people, now-a-days, who are compelled to sustain burdens above their strength. What the sky was to the giant, such are the cares of earth to those who let themselves be weighed down by them. And whenever men undertake what is beyond the just measure of their abilities, they encounter precisely such a doom as had befallen this poor giant.

Poor fellow! He had evidently stood there a long while. An ancient forest had been growing and decaying around his feet; and oak trees of six or seven centuries old, had sprung from the acorn, and forced themselves between his toes.

The giant now looked down from the far height of his great eyes, and, perceiving Hercules, roared out, in a voice that resembled thunder proceeding out of the cloud that just flitted away from his face.

"Who are you, down at my feet there? And whence do you come, in that little cup?"

"I am Hercules!" thundered back the hero, in a voice pretty nearly or quite as loud as the giant's own. "And I am seeking for the garden of the Hesperides!"

"Ho! ho! ho!" roared the giant, in a fit of immense laughter. "That is a wise adventure, truly!"

"And why not?" cried Hercules, getting a little angry at the giant's mirth. "Do you think I am afraid of the dragon with the hundred heads?"

Just at this time, while they were talking together, some black clouds gathered about the giant's middle, and burst into a tremendous storm of thunder and lightning, causing such a pother that Hercules found it impossible to distinguish a word. Only the giant's immeasurable legs were to be seen, standing up into the obscurity of the tempest; and, now and then, a momentary glimpse of his whole figure, mantled in a volume of mist. He seemed to be speaking, most of the time; but his big, deep, rough voice chimed in with the reverberations of the thunder-claps, and rolled away over the hills, like them. Thus, by talking out of season, the foolish giant expended an incalculable quantity of breath, to no purpose; for the thunder spoke quite as intelligible as he.

At last, the storm swept over as suddenly as it had come. And there again was the clear sky, and the weary giant holding it up, and the pleasant sunshine beaming over his

vast height, and illuminating it against the back-ground of the sullen thunder-clouds. So far above the shower had been his head that not a hair of it was moistened by the rain-drops!

When the giant could see Hercules still standing on the sea-shore, he roared out to him anew.

"I am Atlas, the mightiest giant in the world! And I hold the sky upon my head!"

"So I see," answered Hercules. "But, can you show me the way to the garden of the Hesperides?"

"What do you want there?" asked the giant.

"I want three of the golden apples," shouted Hercules, "for my cousin, the king."

"There is nobody but myself," quoth the giant, "that can go to the garden of the Hesperides, and gather the golden apples. If it were not for this little business of holding up the sky, I would make half-a-dozen steps across the sea, and get them for you."

"You are very kind," replied Hercules. "And cannot you rest the sky upon a mountain?"

"None of them are quite high enough," said Atlas' shaking his head. "But, if you were to take your stand on the summit of that nearest one, your head would be pretty nearly on a level with mine. You seem to be a fellow of some strength. What if you should take my burden on your shoulders, while I do your errand for you.

Hercules, as you must be careful to remember, was a

remarkably strong man; and though it certainly requires a great deal of muscular power to uphold the sky, yet, if any mortal could be supposed capable of such an exploit, he was the one. Nevertheless, it seemed so difficult an undertaking, that for the first time in his life, he hesitated.

"Is the sky very heavy?" he inquired.

"Why, not particularly so, at first," answered the giant, shrugging his shoulders. "But it gets to be a little burdensome, after a thousand years.

"And how long a time," asked the hero, "will it take you to get the golden apples?"

"O, that will be done in a few moments," cried Atlas. "I shall take ten or fifteen miles at a stride, and be at the garden and back again before your shoulders begin to ache."

"Well then," answered Hercules, "I will climb the mountain behind you there and relieve you of your burden."

The truth is, Hercules had a kind heart of his own, and considered that he should be doing the giant a favor, by allowing him this opportunity for a ramble. And, besides, he thought that it would be still more for his own glory, if he could boast of upholding the sky, than merely to do so ordinary a thing as to conquer a dragon with a hundred heads. Accordingly, without more words, the sky was shifted from the shoulder of Atlas, and placed upon those of Hercules.

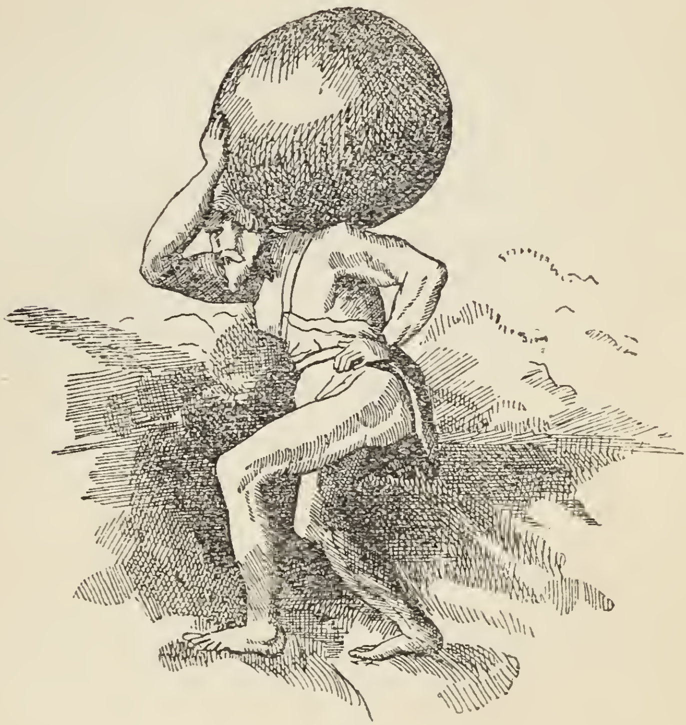
When this was safely accomplished, the first thing that the giant did was to stretch himself; and you may imagine

what a prodigious spectacle he was then. Next, he slowly lifted one of his feet out of the forest that had grown up around it; then, the other. Then, all at once, he began to caper, and leap, and dance for joy at his freedom, flinging himself nobody knows how high into the air, and floundering down again with a shock that made the earth tremble. Then he laughed — Ho! ho! ho! — with a thunderous roar that was echoed from the mountains, far and near, as if they and the giant had been so many rejoicing brothers. When his joy had a little subsided, he stepped into the sea; ten miles at the first stride, which brought him mid-leg deep; and ten miles at the second, when the water came just above his knees; and ten miles more at the third, by which he was immersed nearly to his waist. This was the greatest depth of the sea.

Hercules watched the giant, as he still went onward; for it was really a wonderful sight, this immense human form, more than thirty miles off, half hidden in the ocean, but with his upper half as tall, and misty, and blue, as a distant mountain. At last, the gigantic shape faded entirely out of view. And now Hercules began to consider what he should do, in case Atlas should be drowned in the sea, or if he were to be stung to death by the dragon with the hundred heads, which guarded the golden apples of the Hesperides. If any such misfortune were to happen, how could he ever get rid of the sky? And, by-the-by, its weight began already to be a little irksome to his head and shoulders.

"I really pity the poor giant," thought Hercules. "If it wearies me so much in ten minutes, how must it have wearied him in a thousand years!"

O, my sweet little people, you have no idea what a weight there was in that same blue sky, which looks so soft and



aerial above our heads! And there, too, was the bluster of the wind, and the chill and watery clouds, and the blazing sun, all taking their turns to make Hercules uncomfortable! He began to be afraid that the giant would never come back. He gazed wistfully at the world beneath him, and acknowledged to himself that it was a far happier kind of life to be

a shepherd at the foot of a mountain, than to stand on its dizzy summit, and bear up the firmament with his might and main. For, of course, as you will easily understand, Hercules had an immense responsibility on his mind, as well as a weight on his head and shoulders. Why, if he did not stand perfectly still, and keep the sky immovable, the sun would perhaps be put ajar! Or after nightfall, a great many of the stars might be loosened from their places, and shower down, like fiery rain, upon the people's heads! And how ashamed would the hero be, if, owing to his unsteadiness beneath its weight, the sky should crack, and show a great fissure quite across it!

I know not how long it was before, to his unspeakable joy, he beheld the huge shape of the giant, like a cloud, on the far-off edge of the sea. At his nearer approach, Atlas held up his hand, in which Hercules could perceive three magnificent golden apples, as big as pumpkins, all hanging from one branch.

"I am glad to see you again," shouted Hercules, when the giant was within hearing. "So you have got the golden apples?"

"Certainly, certainly," answered Atlas; "and very fair apples they are. I took the finest that grew on the tree, I assure you. Ah! it was a beautiful spot, that garden of the Hesperides. Yes; and the dragon with a hundred heads is a sight worth any man's seeing. After all, you had better have gone for the apples yourself."

"No matter," replied Hercules. "You have had a pleasant ramble, and have done the business as well as I could. I heartily thank you for your trouble. And now, as I have a long way to go, and am rather in haste,—and as the king, my cousin, is anxious to receive the golden apples,—will you be kind enough to take the sky off my shoulders again?"

"Why, as to that, said the giant, chucking the golden apples into the air, twenty miles high, or thereabouts, and catching them as they came down, "as to that, my good friend, I consider you a little unreasonable. Cannot I carry the golden apples to the king, your cousin, much quicker than you could? As his majesty is in such a hurry to get them, I promise you to take my longest strides. And, besides, I have no fancy for burdening myself with the sky, just now."

Here Hercules grew impatient, and gave a great shrug of his shoulders. It being now twilight, you might have seen two or three stars tumble out of their places. Everybody on earth looked upward in affright, thinking that the sky might be going to fall next.

"O, that will never do!" cried Giant Atlas, with a great roar of laughter. "I have not let fall so many stars within the last five centuries. By the time you have stood there as long as I did, you will begin to learn patience!"

"What!" shouted Hercules, very wrathfully, "do you intend to make me bear this burden forever?"

"We will see about that, one of these days," answered the giant. "At all events, you ought not to complain, if you have to bear it the next hundred years, or perhaps the next thousand. I bore it a good while longer, in spite of the back-ache. Well, then, after a thousand years, if I happen to feel in the mood, we may possibly shift about again. You are certainly a very strong man, and can never have a better opportunity to prove it. Posterity will talk of you, I warrant it!"

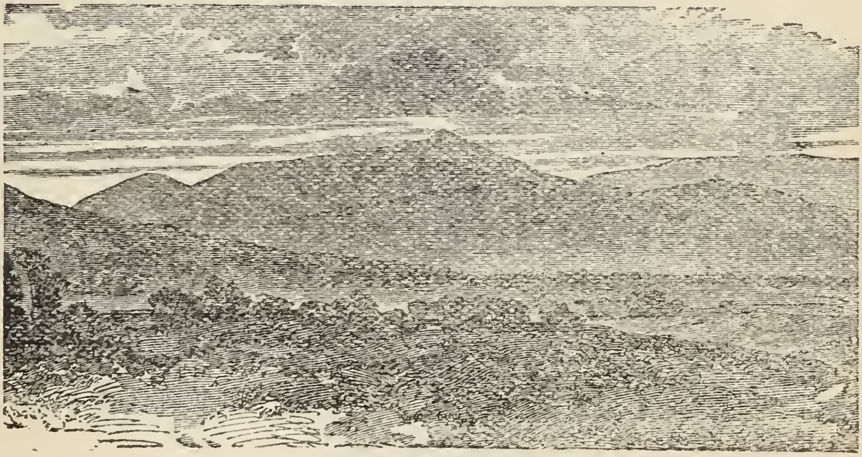
"Pish! a fig for its talk!" cried Hercules, with another hitch of his shoulders. "Just take the sky upon your head one instant, will you? I want to make a cushion of my lion's skin, for the weight to rest upon. It really chafes me, and will cause unnecessary inconvenience in so many centuries as I am to stand here."

"That's no more than fair, and I'll do it!" quoth the giant; for he had no unkind feeling toward Hercules, and was merely acting with a too selfish consideration of his own ease. "For just five minutes, then, I'll take back the sky. Only for five minutes, recollect! I have no idea of spending another thousand years as I spent the last. Variety is the spice of life, say I."

Ah, the thick-witted old rogue of a giant! He threw down the golden apples, and received back the sky, from the head and shoulders of Hercules, upon his own, where it rightly belonged. And Hercules picked up the three golden apples, that were as big or bigger than pumpkins, and

straightway set out on his journey homeward, without paying the slightest heed to the thundering tones of the giant, who bellowed after him to come back. Another forest sprang up around his feet, and grew ancient there; and again might be seen oak-trees, of six or seven centuries old, that had waxed thus aged betwixt his enormous toes.

And there stands the giant, to this day; or, at any rate, there stands a mountain as tall as he, and which bears his name; and when the thunder rumbles about its summit, we may imagine it to be the voice of Giant Atlas, bellowing after Hercules!



"America leads every nation on the globe in inventive genius, and in finding the shortest way to desired ends."—GLADSTONE.

Great Inventions

The Achievements of a Century of Progress

A REVIEW OF THE MOST USEFUL AND VALUABLE INVENTIONS OF THE PAST ONE HUNDRED YEARS : : : : : : :

ILLUSTRATED

CHICAGO:
The George M. Hill Company
Publishers

Contents

A Century of Triumphs

THE CENTURY just fading into the past has assuredly been a great period of time. It has witnessed more of human progress than any five centuries in the history of the race. It has been a century of invention, of research, of audacity —and therefore also, an age of mighty achievement. Merely to have lived in it was a personal privilege. To have marked its activities and heard its bold aspirings was a liberal education.

The triumphs of this wondrous age have been intellectual as well as material. Man has been realizing his power, and in many cases his mastery, over the erstwhile stubborn forces of nature. He has made a servant of the awful and deadly lightning. He calculates and maps out daily the pathway of the storm. He shatters the rock-ribbed hills to make them disgorge their wealth. He builds his watch-towers on the mountain-tops and takes pictures at the bottom of the sea. He outwits time and distance and can baffle or hasten, artificially, the processes of the changing seasons.

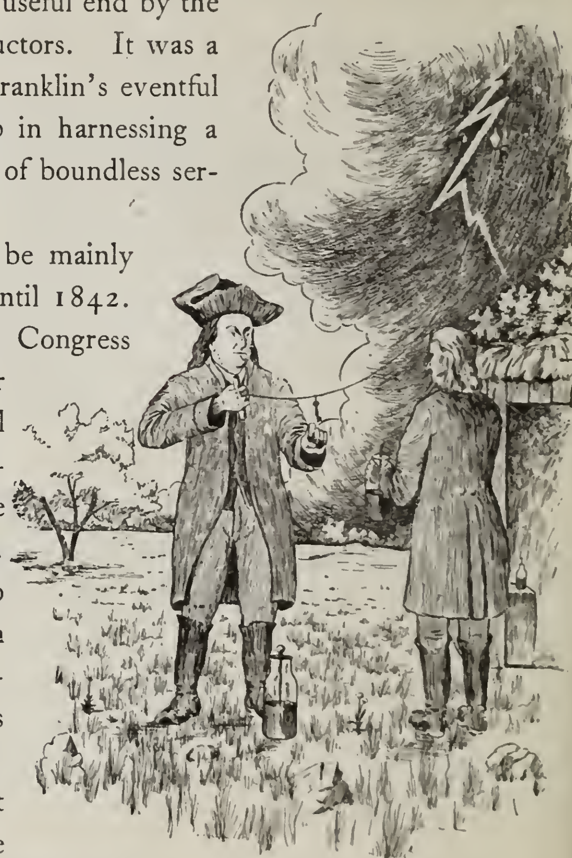
The triumphs of the century concern us all personally. Most of them have something to do with the comforts and conveniences of every-day life. They lessen our toils. They brighten our homes. They diminish the evils of poverty and make wealth more truly enjoyable. They have turned conveniences into necessities and placed the luxuries of the past among our daily experiences. The artisan of the present time can have more of the good things of life than the capitalist of a hundred years ago.

Thus has the progress of a century been working for the common good. Its triumphs are our blessings. And lest we should be indifferent or ungrateful, or mayhap blind to their existence, a selection of them will be reviewed in these pages that "he who runs may read."

Electricity

EVEN centuries ago some of the minor electrical phenomena had been witnessed and wondered at in the resorts of science. It was in 1757 that Benjamin Franklin, by his famous kite experiment, identified the electrical fluid with the lightning of the summer storms. He turned his discovery to a useful end by the invention of lightning conductors. It was a small matter, seemingly, in Franklin's eventful life, but it was the first step in harnessing a power that has since proved of boundless service to mankind.

Electricity continued to be mainly a science of the laboratory until 1842. In December of that year Congress voted a sum of $30,000 for the construction of a trial telegraph line between Washington and Baltimore. The inventor was Prof. S. F. B. Morse, of New York, who had expended about a dozen years in perfecting his invention and pleading for its adoption by the Government. In May, 1844, this, the first message, was sent over the wires: "What hath God wrought."



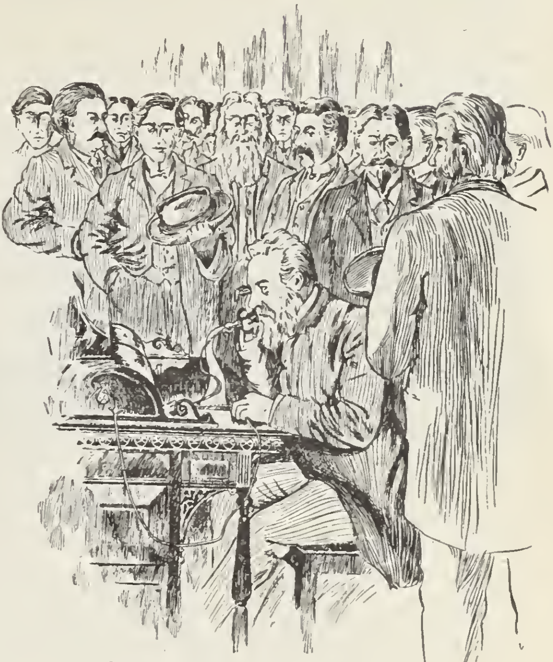
Franklin and Kite.

From that time onward the progress of electrical science was irresistible. It has engaged the talents of numerous great inventors and proved of inestimable benefit to the world at large. When it is considered that the earth itself is a vast storehouse of electricity, and that it is readily converted into motion, heat, light and the energy of chemical

reaction, it will be seen what a mighty resource it is and what a range of utility it covers.

That first short telegraph line has grown into a service embracing all the chief nations. The length of the world's telegraph system is now about 5,500,000 miles, of which one-half is in this country. The number of telegrams sent annually is over 200,000,000.

The electric motor was invented early in the century. Over fifty years ago Jacobi propelled a boat on the Neva by electricity. Prof. Page, in this country, succeeded a few years later in driving a car by electric locomotive between Washington and Bladensburg at 19 miles an hour. Hundreds of thousands of electric motors are now at work, in all parts of this country, railroading freight and passengers, running printing presses, lifting elevators and in every imaginable field of domestic and industrial service. In the operation of street railways they are used in even our smaller towns and apparently will soon be traveling on all the nation's highways.

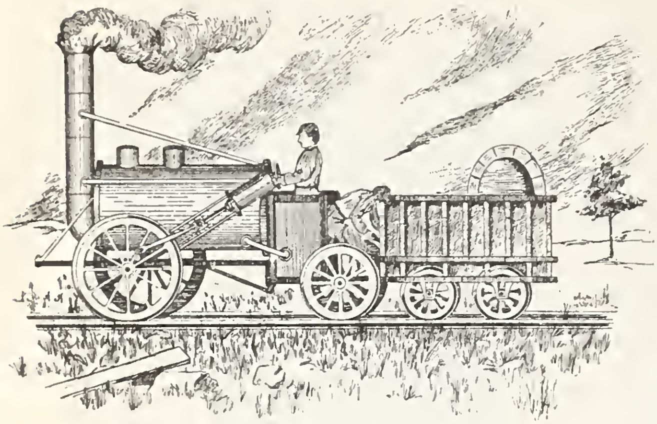


Bell's First Telephone.

Other electrical inventions can only be referred to by jottings. There are over 500,000 miles of exchange telephone service in this country alone, nearly 3,000,000 messages being sent daily. The telephones in use number upwards of 400,000. Electric lighting is now universal in the streets of American cities as well as in offices and countless private homes. Electro-plating is among our most flourishing industrial arts. Medical electricity has brought relief to myriads of afflicted persons. And there are many other branches of electricity.

Transportation

THE facilities of transport by land and sea may be deemed the greatest factor in the world's progress. We owe to the 19th Century both Railroads and Steamships. Just before its dawn they had become barely known in theory and experiment. The Liverpool and Manchester (Eng.) Railway, built by George Stephenson, is usually recorded as the first. On it was made the trial of his locomotive "Rocket" October 6, 1830. The "Rocket" weighed less than four and a half tons and hauled thirteen tons of freight at 29 miles an hour. But poor as were our workshops at the time, this country had already taken steps in the same direction. Prior to 1830 six or eight short railroads had been started here, including the Baltimore and Ohio in 1828. On this road in 1829, the famous Peter Cooper made a successful trip of a locomotive of his own invention.



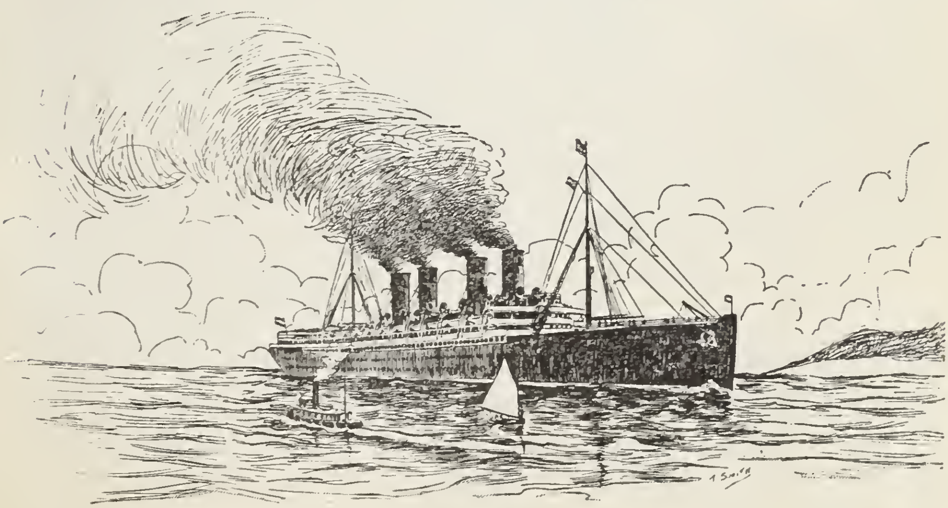
THE FIRST LOCOMOTIVE—(1830).

Having once fairly entered, America took a bold lead in this path of enterprise. Inventions and improvements followed each other rapidly. Locomotives were increased in power, weight and general efficiency. Cars for passengers and freight were developed of better types than have ever been made abroad. The problem of road construction had a large share of attention. The prosperity of the nation has since been measured by the growth of its railroad systems. As it is well said, our domain is now "gridironed" with them.

The passenger coaches of today include elegant Sleeping, Dining, Parlor, Library, Smoking and Observation cars. The type of our chief locomotives is the "Mogul," weighing 90,000 lbs. Our railroads have an aggregate length of 184,894 miles. In 1899 they carried 514,982,288 passengers and moved 912,973,853 tons of freight. As *property* they stand for *twenty billions of dollars.* In speed, as in other matters, they beat the world. A run was made from Chicago to Buffalo, October 24, 1895, at an average speed of 65.07 miles an

hour, parts of the distance (510 miles) being covered at the prodigious rate of 92⅓ miles an hour. This is the world's best.

In 1807 Robert Fulton built a vessel called the "Clermont" at New York, and made the first really successful voyage by steam up the Hudson river. The vessel covered 110 miles in 24 hours against wind and stream. Four years later Henry Bell, of Glasgow, Scotland, made a similar trip on the Clyde in his steamship "Cornet." In 1818 a vessel of this class plied between New York and New Orleans. The year 1838 is memorable in this connection. The steamer "Sirius" sailed from Cork on April 4; the "Great Western" from Bristol, April 8, both arriving in New York on the same day, April 23. Thus began ocean steam navigation. The passage between Queenstown and New York is now made regularly in less than six days. Every ocean on the globe is traversed in palatial steam vessels. Many of these range from 10,000 tons upwards. The "Deutschland," of the Hamburg-American line, has lately headed the ocean record for speed. She is a monster of 16,000 tons, 33,000 horse-power, 686 feet in length, 67½ feet beam, and 44 feet in depth. July 17, 1901, she ended the voyage from New York to Plymouth, England, in 5 days, 11 hours and 5 minutes. The average speed was 23.51 knots, or about 27 land miles an hour. The best day's run was 557 knots. In August, 1900, she made the record western trip, from Cherbourg to New York, in 5 days, 12 hours and 29 minutes. One day's run of this was 675 miles, or upwards of 28 miles an hour—not bad railway speed.

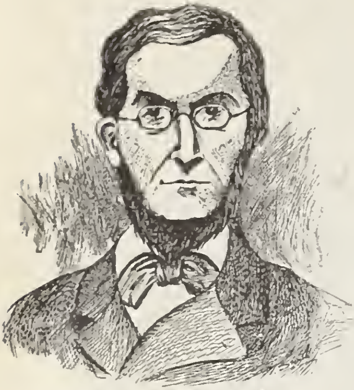


The Ocean Record-Breaker—"Deutschland."

Anesthetics and Antiseptics

THE Nineteenth Century was already a babe of five when Lord Nelson attacked the French fleet at Trafalgar:

"His ship the Victory named,
Long be that Victory famed,
For Victory gained the day!"



DR. W. T. G. MORTON
(Introduced Ether).

In the detailed accounts of the battle we get a vivid glimpse of the scene in the vessel's "cock-pit." There it was the surgeons gave first aid to the wounded borne down from the deck. The place was likened to a butcher's shambles. Amputations were decided on wholesale and with scant formality. The scalpel and saw were used with relentless urgency. A goblet of rum to the shattered victim was the only defense against pain or shock. Many of the brave fellows died under the ordeal of rude surgery. Many more died soon afterward through the evils caused by unsuitable dressing of their wounds. In fact the verdict for amputation was like a sentence of death, while other wounds that penetrated deeply, or touched a vital organ, generally proved fatal through resultant blood-poisoning. At the same period of time, operations in cases of disease were few and timid and scarcely less hazardous than the wounds of battle.

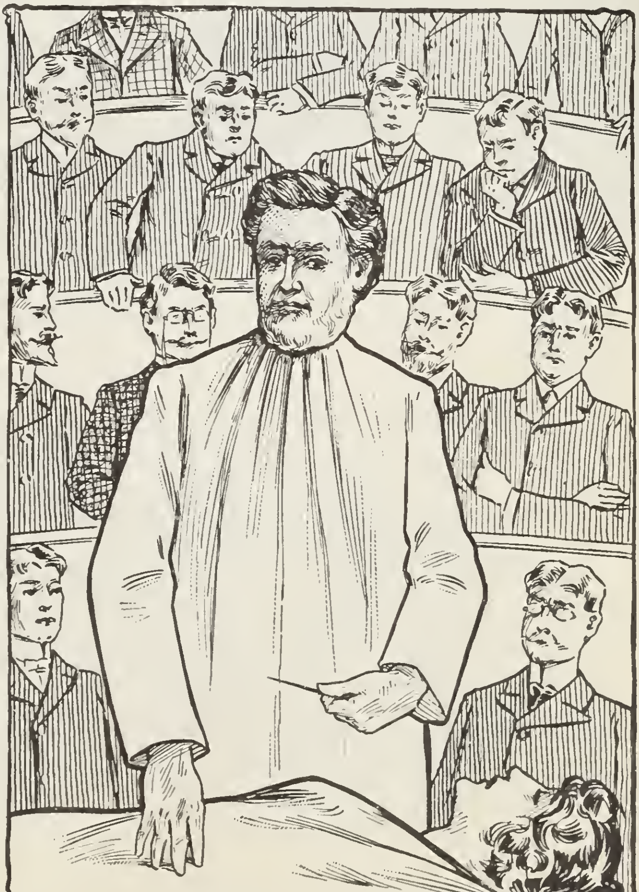
Two kindly discoveries of the century have changed all this. They are named as the title of our brief notice. They have already saved millions of lives that were imperiled by wounds or disease. They have even lifted up surgery itself to the grade of a sure-footed science.

Anesthetics are a series of agents used chiefly to annul pain in surgical operations. By causing insensibility they also give the surgeon time for his delicate work and the relaxed bodily condition which is safest for its performance. The earliest of these to be used, about 1840, was nitrous oxide ("laughing gas"), but it fell into disfavor from want of proper apparatus. Ether was introduced by Dr. Morton in 1846. In the very next year chloroform became known in Europe and speedily won the first preference for anesthesia. Time soon

showed, however, that ether was far less risky in administration, so that the latter agent is now selected by the world's chief surgeons. Cocaine has likewise been found valuable as a local anesthetic.

Antiseptics are a class of substances that prevent or retard putrefaction in animal or vegetable organisms. Their use began almost simultaneously with that of anesthetics. They are the true microbe-killers and therefore arrest quickly all forms of fermentation and decomposition. In the surgery of today they are applied not only to the living tissue but also to the instruments, bandages, bedding and other objects about the patient that might harbor the deadly bacilli. There are numerous antiseptics now available but the best known are chlorine, carbolic acid, iodoform and powdered charcoal.

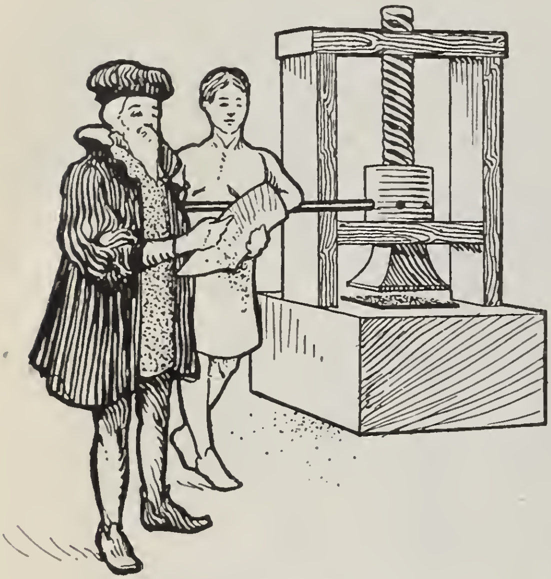
Other recent discoveries, such as the wondrous X Ray, the Murphy button, etc., have done much to help on the latter-day surgery, but anesthetics and antiseptics may well be considered as its broad and trusty foundation. Writing of them lately an eminent professional authority exclaims : "Glorious Nineteenth Century, the past will ever do thee homage! Will the future produce thy peer ?"



Medical College Clinic—(A Painless Operation).

The Printing Press

PRINTING is rightly deemed the greatest of all human arts. It may be said to have had its true beginnings in the invention of movable types about 1425. We pass over all discussion as to the actual inventor. Gutenburg printed a Bible between 1450 and 1455 and the ancient cities of Mayence, Strasburg and Haarlem were cradles of the new and wonderful process. It was about 1471 when William Caxton set up his press in England.



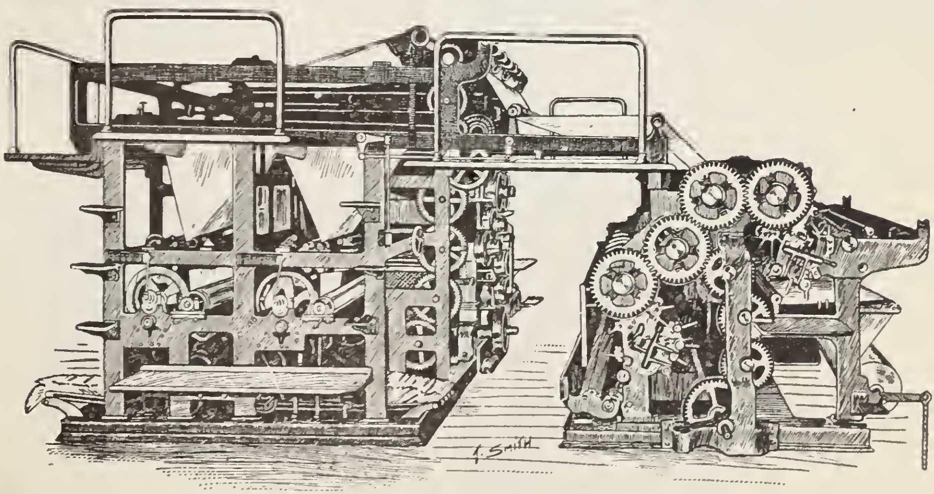
Old Style Screw Press.

The early printing presses were all on the screw principle and of rude and clumsy construction. The first improvements of note were those of Earl Stanhope toward the close of the eighteenth century. He made the press of iron and of a size to print the whole surface of a sheet. He also contrived a lever movement to lighten the pressman's "pull" and thus insure more rapid and efficient work.

The Nineteenth Century has carried this machine to a marveluos degree of perfection. American genius was prompt in undertaking its development. In 1818 George Clymer, of Philadelphia, patented the Columbian press. In this instance the force was applied by a long bar or handle, acting on a combination of exceedingly powerful levers. The same year a patent was taken out in England for cylindrical press machinery. This was the "Applegate" press and soon became the model for steam-presses that were extensively used on book-work. One improvement followed another for the next quarter of a century, all to be vastly outdistanced by the "rotary press" of Richard M. Hoe, of New York. This came out in the late fifties and consisted in placing

the types (afterward substituted by stereotype plates), on a horizontal cylinder revolving on its axis, against which the sheets were pressed by exterior and small cylinders. The early Hoe machine, however, could only print on one side of the sheet at a time, while the world had now grown to be impatient for its morning newspaper.

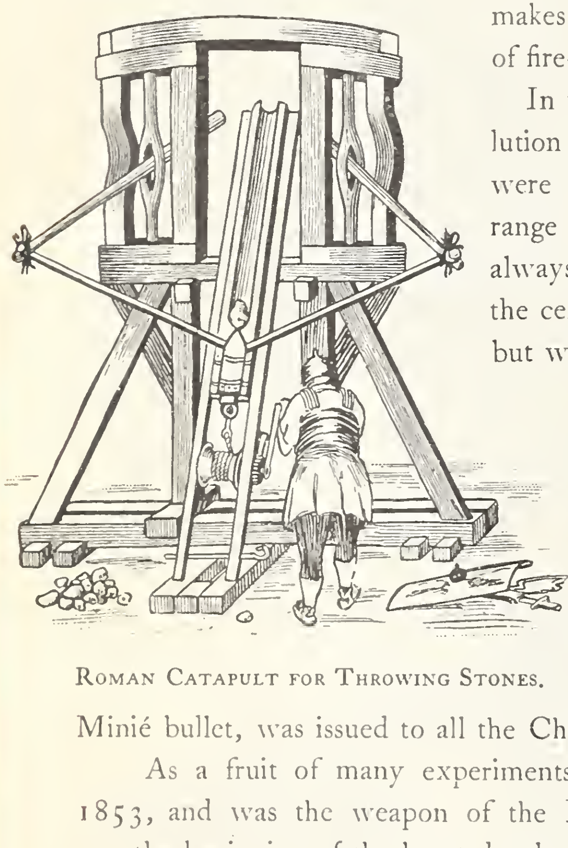
Between 1863 and 1868 the "Walter" press was contrived in London to print both sides by one operation from a continuous roll of paper. This was the first of the so-called "perfecting" presses, in which American skill and ingenuity have since led the world. Of these there are now many, but as a typical and grand achievement we may name the "octuple stereotype insetting machine." This press delivers folded, half-page size, 4, 6 or 8-page papers at the running speed of 96,000 per hour, 10-page papers at 72,000 per hour, 12-page papers at 60,000 per hour, and 16-page papers at 48,000 per hour. A Hoe machine of the perfecting class now operating in Chicago prints off a weekly 16-page paper simultaneously with other sheets for pamphlets, all cut at the head, pasted and folded ready for trimming. After being printed on one side it passes round a "transferrer" to the opposite end of the same cylinder, reversed, and when printed on the other side is passed to the pasting and folding machines, and finally to a machine which collects and adjusts the sections and passes them, cut, on broad belts to the tables, where all are piled for count and delivery. What a revelation would such a machine be to dear old Caxton!



A Modern Newspaper Perfecting Press.
(Running speed, 48,000 per hour.)

Arms and Armor

IN the battles and sieges of the ancients, stones and other projectiles were thrown by the Catapult within a very short range. During the Boer-British war in South Africa men were shot down by a foe so distant as to be invisible to the naked eye. This latter grim fact makes it interesting to note the progress of fire-arms in the Nineteenth Century.



Roman Catapult for Throwing Stones.

In the time of the American Revolution the old flint musket and firelock were the only arms in use. Their range was very limited and the fire always uncertain. At the opening of the century, rifling had become known but was slow to win adoption.

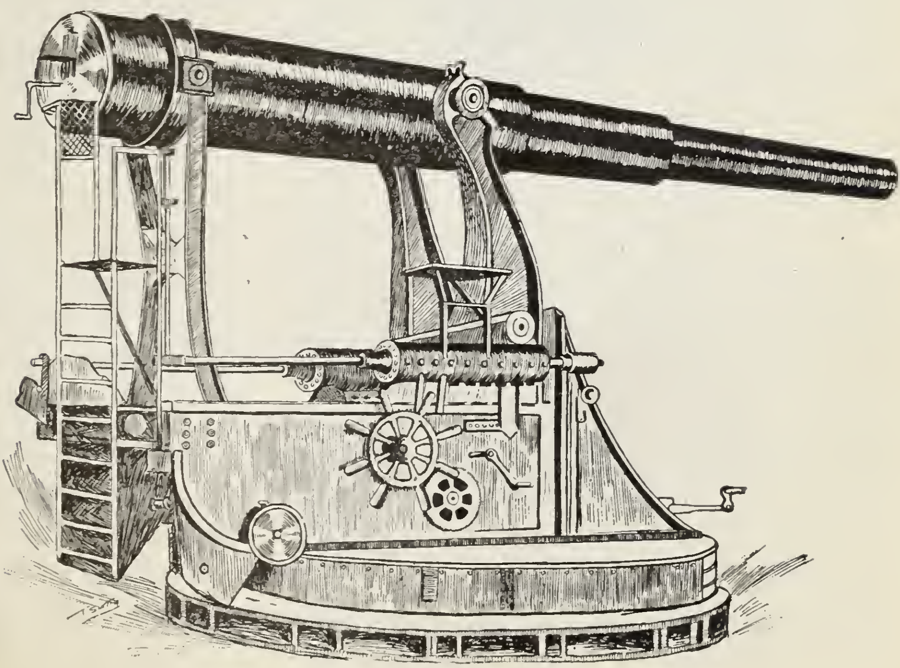
During the war of 1812-14 Americans proved incontestably the superiority of rifled weapons. The first war rifle was that of Capt. Delvigne, adopted in 1826 for a portion of the French army. This weapon with some improvements, including the conical Minié bullet, was issued to all the Chasseurs in 1846.

As a fruit of many experiments, the Enfield rifle came out in 1853, and was the weapon of the British army until 1865. This was the beginning of the latest development in small arms. When our civil war broke out the best rifles in the world were all muzzle-loaders, firing conical bullets at the rate of about one per minute. Sharp's carbines and the Burnside rifle were used for a time in our armies, but were finally displaced by the Spencer magazine-gun. This carried in the stock seven metallic cartridges which could be fired off and replaced every ten seconds. As against any form of muzzle-loaders it was

simply invincible, and in 1865 was the world's greatest rifle. The Krag-Jorgensen was adopted in 1892. It is a bolt-gun with a five-cartridge magazine, fed by hand, its bullet velocity being 2,000 feet per second. The Mauser is a Belgian weapon having a bullet of soft lead in a casing. It is otherwise like the Krag-Jorgensen. It is risky to be within 2,000 yards of any of these new-fashioned guns.

At the beginning of the century, the largest cannon was a smooth-bore 42-pounder. The American Civil War gave the first great impetus to progress in this line. Thus were produced the 300-lb. rifled Parrott and the 450-lb. 15-inch smooth-bore Rodman.

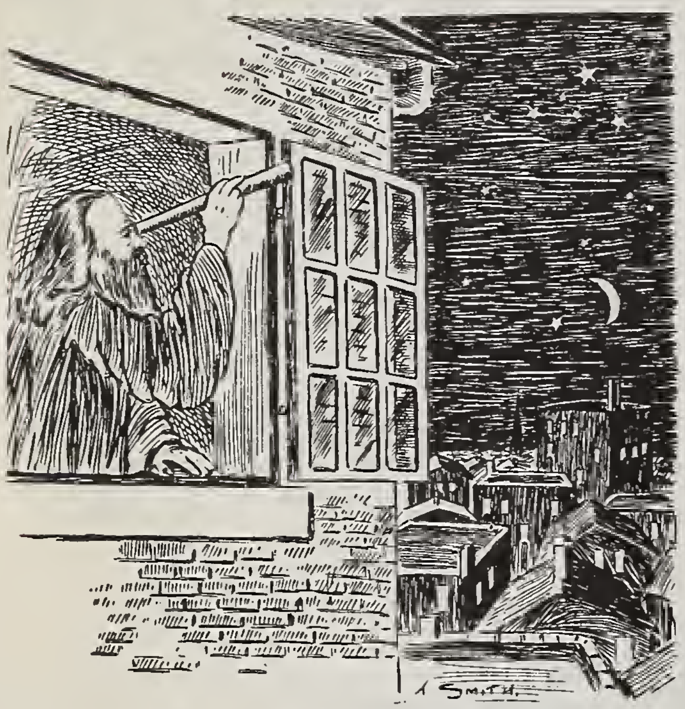
Experiments abroad were now incessant, culminating a few years ago in 100-ton guns by Krupp of Germany and Armstrong of England. One of the latest Krupps is a 140-ton gun, 52½ ft. long, using 1,069 lbs. of prismatic powder to a charge and shooting a projectile of 2,314 lbs., able to penetrate wrought iron plates 4 feet in thickness. This weapon is handled entirely by hydraulic machinery, and a single service discharged is said to cost $800. The range of big guns like this is variously stated at 4 to 12 miles, and the maximum of destructiveness is not yet reached.



Modern Disappearing Gun—(Elevated.)

Telescopes Old and New

ON the night of January 1, 1801, being the first of the Nineteenth Century, the Italian astronomer Piazzi discovered the minor planet to which he gave the name of Ceres. It was one of a group of bodies, now called the asteroids, that revolve in the solar system between Mars and Jupiter. The date was of good omen, for in the course of this wondrous century upwards of 400 similar asteroids were identified and catalogued in succession to Ceres. All these were unseen by previous astronomers because of their imperfect telescopes.



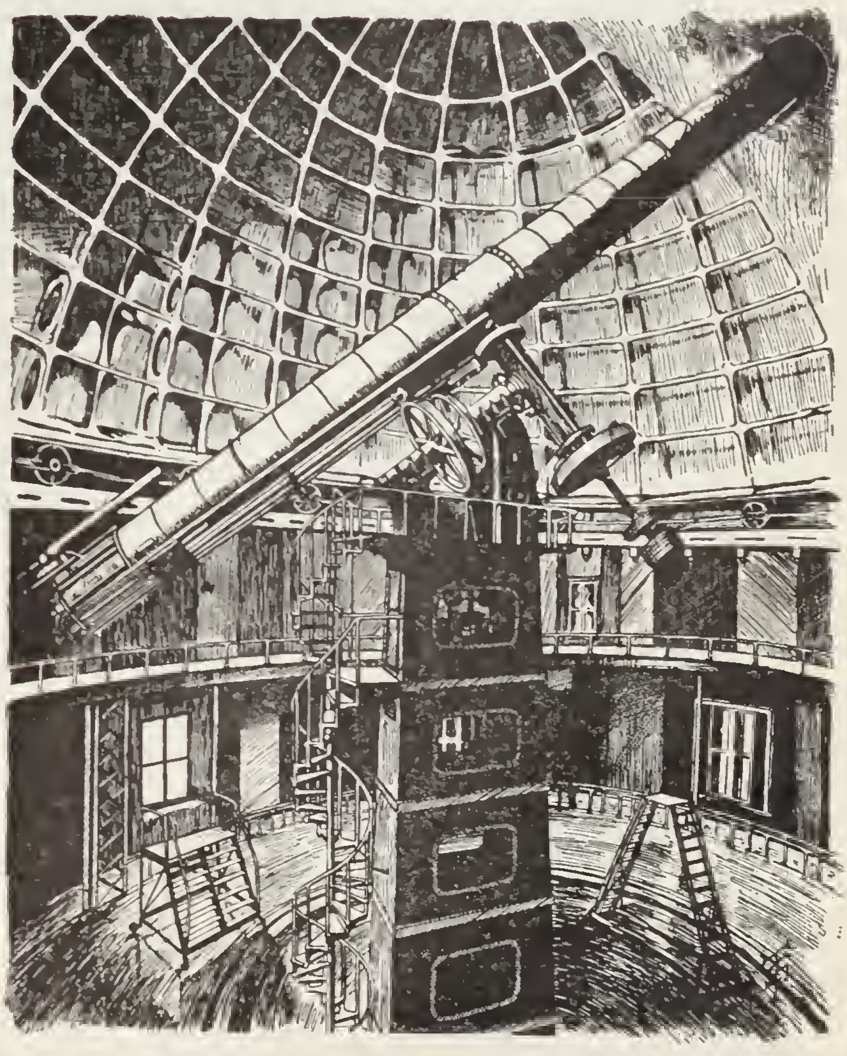
Piazzi Searching the Heavens.

It was Herschel, who was then living, that first made serious efforts to improve the telescope. The kind then chiefly used were reflectors. His remarkable success was due to his skill in polishing mirrors for them. It was he who discovered the planet Uranus and its four satellites. He found two additional moons of Saturn. He determined the direction of motion of the solar system in space. He proved that the Milky Way was composed of countless myriads of stars.

Bessel, of Konigsberg, was the great astronomer of the early part of the century. He computed with accuracy the orbit of Halley's Comet. He first developed the theory of correcting for instrumental errors. He fixed the standard length of seconds-pendulums and made numerous observations and discoveries of great importance. Next in eminence comes Argelander, Bessel's pupil, who made a complete catalogue, with maps, of all the stars down to ninth magnitude between 2° of declination and the North Pole, containing in all 320,000 stars. The younger Herschel, also made precious observations.

Through these we reach the period of the "new" astronomy. Chemistry came with its aid in the spectrum analysis. Photography fixed the stellar phenomena for leisurely study. The improvements in glass-making and in mechanism caused the production of "refractor" telescopes of prodigious power. Even the use of incandescent lights has wonderfully aided the investigations of the astronomer.

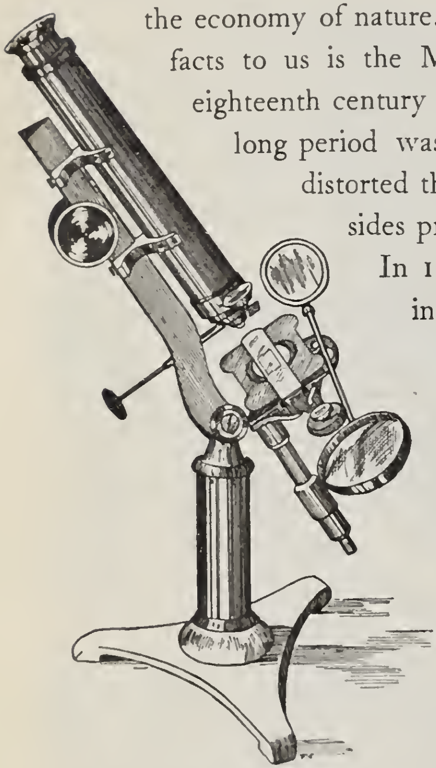
A mere list of recent astronomical discoveries would exceed our space. The greatest triumph of the century was the discovery of the planet Neptune by Leverrier and Adams. Sir George B. Airy has furnished an elaborate theory of the moon's motion. Encke, for whom a comet has been named, devised methods of computation of great value. Prof. Newton, of Yale, has told us about all we can know of meteorites or shooting stars. Two other American astronomers, Newcomb and Hill, have proved worthy rivals of the Europeans in their studies of solar phenomena, cometary movements and nebulæ. Eclipses of sun and moon have also been closely studied by astronomers generally. The great telescope-maker of the new period was the late Alvan Clark of Cambridge, Mass. To his firm are due the huge objectives of the Lick telescope of 36-in. and the Yerkes of 40-in. diameter. The future progress of the science is well assured by these magnificent instruments and able astronomers who use them.



THE GREAT LICK TELESCOPE.

Told by the Microscope

IT is hard to imagine objects so extremely small that a sharp eye would be unable to detect them. But science tells us of matter in various forms, and even of countless living organisms, that are invisible though everywhere about us, and that they play an important part in the economy of nature. The instrument that makes known those facts to us is the Microscope. It was invented late in the eighteenth century by a dutchman named Jansens, but for a long period was chiefly regarded as a scientific toy. It distorted the outlines of objects viewed through it, besides presenting them in a maze of colors.



A Compound Microscope.

In 1816 Wollaston corrected these faults by the invention of what is called the achromatic object-glass. This was further improved in 1829 by Jackson Lister. Various eminent scientists now gave their attention to the instrument and the new field of research which it opened up to them. It was still very imperfect, however, as compared with the Microscopes of today, when in 1858 Charles Darwin electrified the world by publishing his researches in the famous "Origin of Species." Out of this sprang up the new science of biology, and both friends and foes of the Darwinian theory appealed to the Microscope for evidence to sustain their respective views. The magnifying powers of the instrument were now greatly augmented. The Micrometer was added to it for giving measurements of the objects examined. The improvements in making flint-glass insured better lenses. It became possible to see things magnified to several hundred times their actual size.

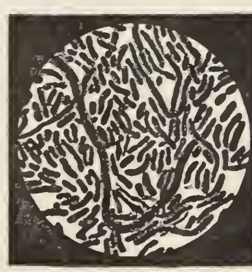
Once more a new realm of science was entered upon. Pasteur

and other investigators began to find in microscopy the solution of momentous problems. Fermentation and decay were found to be the work of prolific living organisms. Even the mould on damp hay was seen to be an organism that propagated itself to 300,000,000 in twenty-four hours. The bacteria of disease were next discovered. Medical science was revolutionized when it found that the most serious maladies could be diagnosed by putting in a Microscope the sputa or blood of a patient. Discoveries in regard to hydrophobia, tuberculosis, typhoid, cholera and other morbid conditions have since been the means of saving myriads of human lives. Bacteriology became a department of medical study.

There is something in the extreme of minuteness, which is no less wonderful than the extreme of vastness. If the mind loses itself in the contemplation of the immeasurable depths of space, and of the innumerable multitudes of stars, it is equally lost in wonder and admiration, when the eye is turned to those countless multitudes of living beings, which a single drop of water may contain.

The Microscope of to-day identifies crystals for the chemist and metals for the mineralogist. For the geologist it interprets the rocks and the elements of deep-sea soundings. It guides the miner to his gold and the farmer to his harvest. It tells the tale of a blood-stain to sightless Justice. Scarcely a science, art or industry but is indebted to it for a new and helpful light. The invisibly little has become the immensely significant.

HUMAN BLOOD
UNDER THE
MICROSCOPE.



As it Appears in Health.

Infected with Cholera.

Conquests of the Camera

THE Camera has been familiar to the curious since the Thirteenth Century. Down to the Nineteenth Century it was little else than a toy of the laboratory. In 1839 a Frenchman named Daguerre succeeded in making with it, by the action of the sun's rays, the first permanent photograph. His process at once came into use for portrait-taking and is still known as the Daguerreotype.

L. J. M. Daguerre.

The new art flourished like a green bay tree. Chemistry flew continually to its aid with materials and hints for using them. Fresh discoveries in optics enlarged its aims. Great scientists like Morse, Brewster and Draper became its helpful votaries. Improvements in the Camera and its belongings made picture-taking a delight to amateurs. Then, as at a bound, the art grew into a science and has since been doing service to almost every other science and field of research or activity. A few instances must show its outcome.

Photo-engraving has sprung from it as a special art and is fast replacing all others in pictorial illustration. The beauty and fidelity of the work done by it, in reproducing scenes from nature, paintings, architecture and incidents of real life, have won for it the leading place in our magazine and book literature. It has many processes, some of which are so speedy as to serve the news departments of the daily press. Photography has been made available also in simplifying the processes of wood, zinc, steel and copper-engraving.

In microscopy this art is used to produce an enlarged image of the microscopic object, thus giving powerful aid to the researches of medical experts and kindred investigations. In astronomy, on the other hand, it is now continually employed to record telescopic impressions of the sun's and moon's phases, the planets and their satellites,

the orbits of comets, the flight of meteors and the positions and phenomena of stars down to the faintest nebulae that glimmers in celestial space. The advance of astronomical science has thus been greatly promoted while a crowning service will be rendered to it by the photographed chart of the heavens that has for years been preparing in sections at the leading observatories.

To the development of instantaneous and electrical photography we owe a number of recent inventions that have a recreative as well as scientific value. The Kinetoscope, Mutascope and similar devices for showing continuous action, such as a stage exhibit or a prize-fight, are now familiar to the general public.

The latest and greatest victory of photographic science is the discovery of the X-Ray by Prof. Roentgen. By this we are enabled to take pictures through what are commonly opaque media, so that the bones of a living animal can be accurately photographed although covered with flesh. The practical value of such pictures in surgery and medicine will be plain to everybody. By locating internal conditions and lesions, or such foreign substances as a bullet, they have advanced diagnosis to a standard of precision otherwise impossible. Already has the X-Ray saved thousands of precious lives and no well-equipped hospital is now unprovided with the Roentgen apparatus.

X-Ray Photograph of Hand.
(Showing Bones and Ring).

The Sewing-Machine

IT is barely over seventy years, the span of a single lifetime, since Thomas Hood produced his famous "Song of the Shirt." The world that was moved by its pathos also felt its truth:

By the Candle's Dim Light.

"With fingers weary and worn,
With eyelids heavy and red,
A woman sat in unwomanly rags
Plying her needle and thread—"

It was a picture only too faithful of the average seamstress of the period. Long hours, ceaseless toil and very scanty pay were the usual conditions. And as these almost necessarily imply squalid homes and unsanitary surroundings, the poet correctly framed his typical needle-woman:

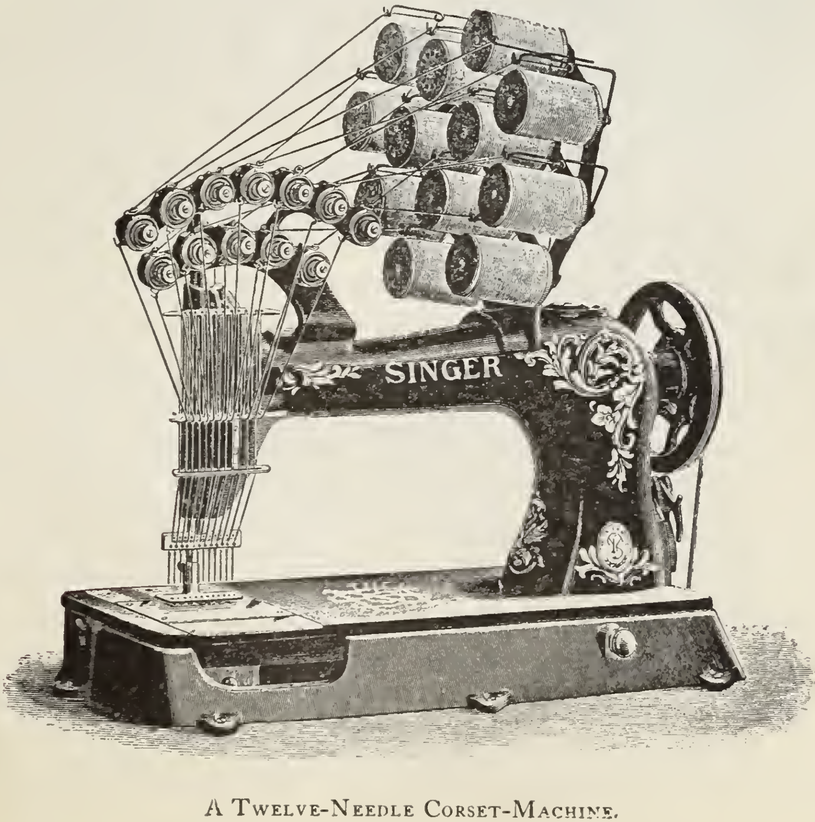
"In poverty, hunger and dirt,
Sewing at once, with a double thread,
A shroud as well as a shirt!"

Alas, it was even so with thousands upon thousands in the richest of the world's capitals! But here again it was the spirit of invention, the genius of the Nineteenth Century, that brought relief to a host of toilers who had suffered hopelessly for ages before.

The Sewing-machine ranks high among the important inventions of our time. Like the stocking-frame, which it resembles in principle, we owe it to the ingenuity of a poor mechanic, striving to lessen the labor which he saw was such a hardship to his wife and other women. This artisan was Elias Howe, of Massachusetts. He completed his first practical Sewing-machine in 1841, and during the same year obtained a patent for it. He could not induce capital, however, to foster his invention, so he took it to England, where he also patented it, but met with so much discouragement that he sold his patent for $1,250. When Howe reached his own country he found his Ameri-

can patent had been pirated by a wealthy company. He began a litigation, which he kept up with much spirit till his rights were established, finally amassing a large fortune.

Howe's machine worked what is called the "lock-stitch,"but since his invention became known, numerous improvements and modifications have been devised by others. Attachments of various kinds have also been provided for the better class of machines, while special machines were contrived for leather-work, upholstering, book-binding and similar crafts. From 1869 to 1875 thirty-two Sewing-machine companies were formed in the United States, the aggregate of their sales being over 6,000,000 machines. Most of these firms collapsed or were absorbed by others as their patents expired, and now the field is open to all who can make Sewing-machines. The output up to date is simply incalculable. Every home in civilized lands is provided with its Sewing-machine. The needle-women of the present do their work under very different circumstances from those of Hood's time.



A Twelve-Needle Corset-Machine.

Applied Chemistry

THE germs of the true science of chemistry appeared in the dawn of the Eighteenth Century. In 1732 Boerhaave published his experiments on the chemical relations of heat and light. In 1756 Black made known his researches into the nature of carbonic acid. About the same time Margraft extracted sugar from plants and discovered the two new earths, alumina and magnesia. In 1770 the discovery of oxygen was announced by Priestley and two years later that of nitrogen by Rutherford. Meanwhile some knowledge had been gained of the law of chemical affinities, of combustion and of electro-chemistry. Thus the infant science was helped on by its devotees, one supplying an acid and the next one a new mineral or theory, until near the close of the century, Lavoisier ranged in order the scattering discoveries, framed a system of nomenclature and in fact laid the broad framework on which chemistry still rests. It was the glory of the Nineteenth Century to build on this foundation such a temple of beauty and utility as the alchemists of old could never dream.

MICHAEL FARADAY.

We can barely find space for the chief discoveries. Early in the century the production of chlorine led to the general use of bleaching powder. In 1826 Faraday discovered benzone in the waste of tar of the gas-works, an oil that became later the source of aniline and of numberless beautiful dyes, as well as of antipyrin, antifebrin and a host of medicinal compounds. Similar waste products in other industries have been converted into ways of utility and profit. Liebig and others led the march of chemistry into new fields. It became the privilege of science to lend its subtle processes in aid of almost every art and industry.

In 1847 was patented a process for making gun-cotton, still a most valuable explosive for submarine operators. Shortly after this followed nitro-glycerine, which in 1867 was developed into the terrible dynamite. Chemistry created the starch sugar industry by which thousands of bushels of corn are in this country daily converted into sugar, with an annual product of 225,000 tons, worth $10,500,000.

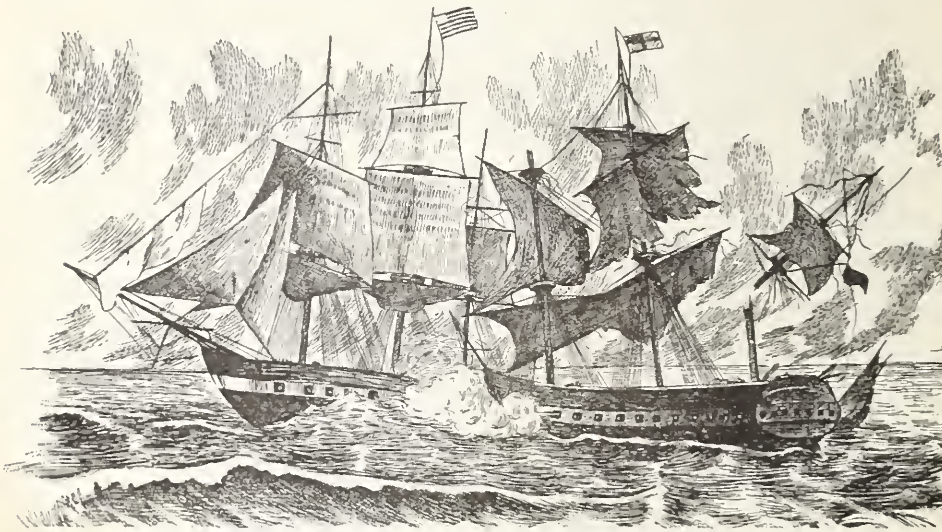
Wood pulp, aluminum, matches, superphosphates and the whole list of artificial manures, spectrum analysis, and the art of photography are but a few of the most important examples of the progress of Applied Chemistry. Agricultural chemistry is contributing yearly more and more to the material wealth of the world. Under its guidance the manufacture and use of fertilizers, superphosphates, potash salts and nitrates are extending. Public health, too, is receiving aid from the chemists. Food and water analysis, the nature and use of disinfectants, the remedy of river pollution, ventilation, physiological chemistry, pharmacy, are among the many subjects which to-day are being investigated by the chemist and profiting by his science.

Ye Alchemist of Old.

Chemistry has proved the absolute unchangeableness of every particle of matter, hence, the indestructibility of matter is one of the conclusions of modern science. As Tyndall eloquently says: "To nature nothing can be added, from nature nothing can be taken away. Waves may change to ripples, and ripples to waves; magnitude may be substituted for number and number for magnitude; the flux of power is eternally the same. It rolls its music through the ages, and all terrestrial energy, the manifestations of life as well as the display of phenomena are but the modulations of its rythm."

Fighting Afloat

THE ancient idea of a war vessel was a beaked wooden galley, almost V-shaped in section and having one or two masts that carried square sails. The curved prow was made to serve as a ram. The hull within was fitted with breast-works and turrets for the fighting-men. Sometimes there were barbetted structures on the masts, in



Battle Between Wooden Frigates (1812).

which men with military engines were stationed to shoot projectiles. It was with fleets of such galleys that the Greeks fought at Salamis and the Romans devastated Carthage. It was in shoals of even ruder vessels that the Scandinavian Vikings sailed to their conquest of Britain.

It is a big stride from the galley to such a war vessel as the old frigate, Constitution, which was the type of all others at the opening of the Nineteenth Century. Except that they mounted guns they differed but little from ordinary sailing craft. They were an evolution of the galley through caravel and merchant ship.

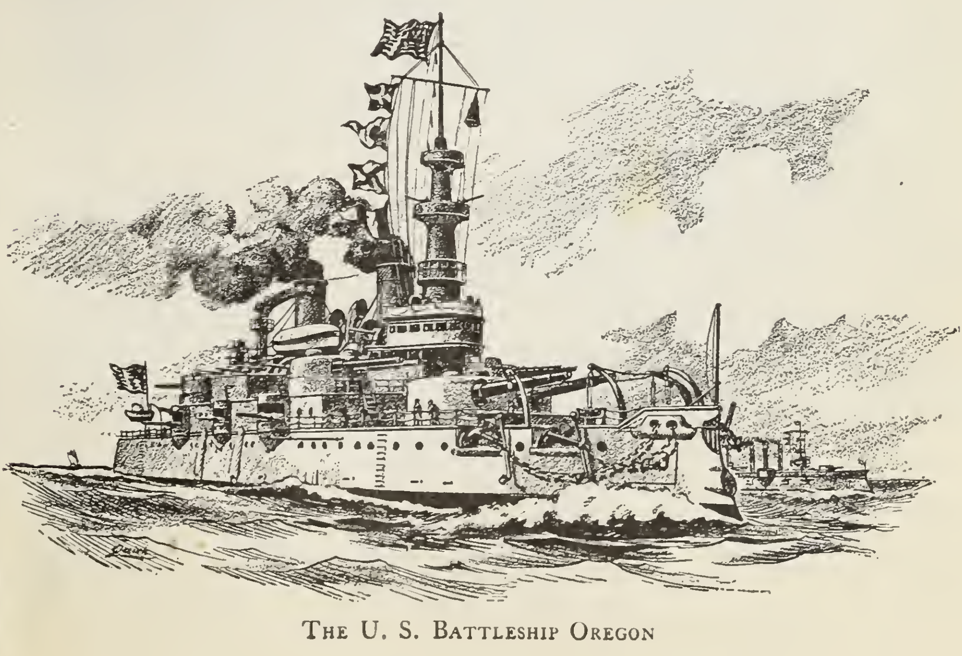
The genius of the Nineteenth Century made the war vessel a type apart. It grew out of the development of steam navigation, gunnery and armor-plating. It is a formidable engine of destruction and comprises many classes in the world's chief navies. Our American models will describe the best afloat.

The sea-going Battleship is a twin-screw steel vessel, minutely subdivided, with an inner bottom and a ram bow. The whole or part of its water-line is protected by a heavy armor. It carries guns in

armored barbettes, or turrets, of such power as to be able to pierce the armor of an opponent at fighting range and capable of directing fire either ahead or astern. It has an armored conning-tower from which it is maneuvered, and carries many guns of smaller caliber partly protected, a number of which are "rapid-firers," mounted along the upper deck and in the military tops. There are tubes for discharging torpedoes below water, and the engines and boilers are protected by a steel deck.

Here are the figures of the famous U. S. Battleship "Oregon," which was launched in 1891 at the Mare Island navy yard, San Francisco: Displacement, 10,288 tons; speed, 16 knots; horse-power, 9,000; cost $3,180,000; armament, main battery, four 13-inch, and eight 8-inch breech-loading rifles; secondary battery, twenty 6-pounders and six 1-pounder rapid-fire guns, with four Gatlings. The "Oregon" proved her sea-going qualities during the late Spanish-American war by steaming around Cape Horn to join the North Atlantic squadron. She left San Francisco, March 12, 1898, and reached Jupiter Inlet, Fla., May 24 following, ready for the work that amazed the maritime world.

Other classes of modern fighting vessels include armored and protected Cruisers, Monitors, Gunboats, unarmored steel vessels, Torpedo Boats and submarine craft, all of which are sufficiently described by their titles.



THE U. S. BATTLESHIP OREGON

DOMESTIC POSTAGE.

FIRST-CLASS MATTER.—Letters and all other written matter (whether sealed or not), excepting manuscript copy accompanying proof-sheets, also all matter sealed (see below), 2 cents an ounce, excepting drop letters, at NON-CARRIER offices, 1 cent an ounce. (Postal cards 1 cent each.)

SECOND-CLASS.—Newspapers and periodicals published quarterly and oftener, and not for gratuitous distribution. The general public pay by affixing stamps at the rate of 1 cent for each 4 ounces or fraction when not sealed.

THIRD-CLASS.—Books (printed, not blank), circulars, other printed matter, proof-sheets and manuscript copy accompanying same, valentines, sheet-music, heliotypes, chromos, posters, lithographs and printed advertising matter in general, all, when not sealed, 1c. for two ounces or fraction.

FOURTH-CLASS.—Merchandise and samples, including printed matter in quantity, blank books and paper, ores, all matter not included in any of the other classes, and not in its nature perishable or liable to injure the contents of the mails. (By express ruling the postage on seeds, cuttings, roots, scions and plants is at the rate of 1 cent for each 2 ounces.) All, when not sealed, and not exceeding 4 pounds in weight, 1 cent an ounce or fraction.

Domestic Classification and Rates apply to and from United States and island possessions of Porto Rico, Hawaiian Islands, Philippines, Guam and Tutuila (Samoan group). United States postage stamps used.

SEALING.—Any matter is regarded as sealed when it is not so wrapped as to allow of a thorough examination without in any way injuring the wrapping.

REGISTRATION.—First, third and fourth class matter may be registered at any post-office by affixing 8 cents in stamps in addition to the regular postage.

MONEY ORDER RATES.—Sums not exceeding $2.50..3c.

Over $ 2.50 and not exceeding $ 5.00.......... 5c.
Over $ 5.00 and not exceeding $ 10.00.......... 8c.
Over $10.00 and not exceeding $ 20.00..........10c.
Over $20.00 and not exceeding $ 30.00..........12c.
Over $30.00 and not exceeding $ 40.00..........15c.
Over $40.00 and not exceeding $ 50.00..........18c.
Over $50.00 and not exceeding $ 60.00..........20c.
Over $60.00 and not exceeding $ 75.00..........25c.
Over $75.00 and not exceeding $100.00..........30c.

POSTAGE TO CANADA AND MEXICO.—Same as domestic rates, excepting fourth-class matter, to the amount of 4 pounds 6 ounces, with the exception of liquids, pastes, confections and fatty substances, and publications which violate any copyright law. To Canada and Mexico (except sealed packages and liquids), Com. papers to both countries at usual rates.

FOREIGN POSTAGE.

All countries are included in the POSTAL UNION, to which the rates are as follows: Letters, per half ounce, 5 cents; second and third class matter, per 2 ounces, 1 cent; postal cards, 2 cents each.

INTEREST LAWS AND STATUTES OF LIMITATIONS.

States and Territories.	Interest Laws.		Statutes of Limitations.		
	Legal Rate.	Rate Allowed by Contract.	Judgments. Years.	Notes. Years.	Open Acc'nts. Years.
	Per ct.	Per ct.			
Alabama.......	8	8	20	6*	3
Arkansas.......	6	10	10	3–5	3
Arizona.........	7	Any rate.	5	5	8
California......	7	Any rate.	5	2–4	2
Colorado.......	8	Any rate.	6	6	6
Connecticut....	6	6	20	6	6
Delaware......	6	6	20	6	3
D. of Columbia.	6	10	12	3	3
Florida.........	8	10	20	5	4
Georgia.........	7	8	7	6–20	4
Idaho.........	7	12	6	5	4
Illinois..........	5	7	20	10	5
Indiana.........	6	8	20	10	6
Indian Territ'y.	6	10	10	5	3
Iowa............	6	8	20	10	5
Kansas.........	6	10	5	5	3
Kentucky (*a*)..	6	6	15	15	2-5(*a*)
Louisiana.......	5	8	10	5	3
Maine..........	6	Any rate.	20	6–20	6
Maryland......	6	6	12	3–2	3
Massachusetts.	6	Any rate.	20	6	6
Michigan.......	5	7	6–10	6	6
Minnesota......	6	10	10	6	6
Mississippi......	6	10	7	.6	3
Missouri........	6	8	10	10	5
Montana........	10	Any rate.	10	8	3
Nebraska......	7	10	5	5	4
Nevada	7	Any rate.	6	6	4
N. Hampshire..	6	6	20	6	6
New Jersey....	6	6	20	6	6
New Mexico....	6	12	7	6	4
New York......	6	6††	20	6	6
North Carolina	6	6	10	3*	3
North Dakota..	7	12	10(*f*)	6	6
Ohio............	6	8	5–26	15	6
Oklahoma.....	7	Any rate.	1–5	5	3
Oregon..........	6	10	10	6	6
Pennsylvania..	6	6	20	6	6
Rhode Island...	6	Any rate.	20	6	6
South Carolina	7	8	20	6	6
South Dakota..	7	12	10	6	6
Tennessee......	6	6	10	6	6
Texas...........	6	10	10	4	2
Utah............	8	Any rate.	8	6	4
Vermont.......	6	6	8	6	6
Virginia........	6	6	10–20	5–10	2–3
Washington....	7	12	6	6	3
West Virginia..	6	6	10	10	5
Wisconsin......	6	10	20	6	6
Wyoming......	8	12	5	5	8

* Under seal, 10 years. †† New York has by a recent law legalized any rate of interest on call loans of $5,000 or upward, on collateral security. (*a*) Building and Loan Associations may charge 12 per cent interest and premium together. Actions on merchants' accounts must be commenced in two years. (*f*) Ten years in new law, 20 years in old law.

Population of Leading Cities in U. S.

(OFFICIAL CENSUS OF 1900.

New York......3,437,202
Chicago, Ill.....1,698,575
Philadel., Pa...1,293,697
St. Louis, Mo.....575,238
Boston, Mass.....560,892
Baltimore, Md...508,957
Cleveland, O.....381,768
Buffalo, N. Y.....352,219
S. Francisco, Cal.342,782
Cincinnati, O.....325,902
Pittsburg, Pa.....321,616
N. Orleans, La....287,104
Detroit, Mich.....285,704
Milwaukee, Wis..285,315
Washington, D. C.278,718
Newark, N. J.....246,070
Jersey City, N. J..206,433
Louisville, Ky....204,731
Minneapolis, Min.202,718
Providence, R. I. 175,597
Indianapolis. Ind.169,164
Kansas City, Mo..163,752
St. Paul. Minn....163,632
Rochester, N. Y..162,435
Denver, Col.......133,859
Toledo, O.........131,822
Allegheny, Pa....129,896
Columbus, O......125,560
Worcester, Mass..118,421
Syracuse, N. Y...108,374
New Haven, Conn.108,027
Patterson, N. J...105,171
Fall River, Mass.104,863
St. Joseph, Mo...102,979
Omaha, Neb......102,555
Los Angeles, Cal.102,479
Memphis, Tenn..102,320
Scranton, Pa......102,026
Lowell, Mass......94,969
Albany, N. Y......94,151
Cambridge, Mass.91,886
Portland, Ore......90,426
Atlanta, Ga..... ..89,872
Gr'd Rapids, Mch..87,565
Dayton. O.........85,333
Richmond, Va.....85,C50
Nashville, Tenn...80,865
Seattle, Wash.....80,671
Hartford. Conn....79,850
Reading, Pa.......78,961
Wilmington, Del..76,508
Camden, N. J......75,935
Trenton, N. J......73,307

Bridgeport, Conn..70,906
Lynn, Mass........68,513
Oakland, Cal......66,960
Lawrence, Mass...62,559
N. Bedford, Mass..62,442
Des Moines, Ia....62,139
Springfield, Mass..62,059
Somerville, Mass..61,643
Troy, N. Y.........60,651
Hoboken, N. J.....59,364
Evansville, Ind....59,007
Manchester, N. H.56,987
Utica, N. Y........56,383
Peoria, Ill.........56,100
Charleston, S. C...55,807
Savannah, Ga......54,244
Salt Lake City, U..53,531
San Antonio, Tex..53,321
Duluth, Minn......52,969
Erie, Pa............52,733
Elizabeth, N. J....52,130
Wilkesbarre, Pa...51,721
Kansas City, Kas..51,418
Harrisburg, Pa....50,167
Portland, Me......50,145
Yonkers, N. Y.....47,931
Norfolk, Va. 46,624
Waterbury, Conn..45,859
Holyoke, Mass....45,712
Ft. Wayne, Ind....45,115
Youngstown, O....44,885
Houston, Tex......44,633
Covington, Ky.....42,938
Akron, O.......... 42,728
Dallas, Tex........42,638
Saginaw, Mich....42,345
Lancaster, Pa.....41,459
Lincoln, Neb......40,169
Brockton, Mass....40,063
Binghamton, N.Y.39,647
Augusta, Ga.......39,441
Pawtucket. R. I....39,231
Altoona, Pa.......38,973
Wheeling, W. Va..38,878
Mobile, Ala........38,469
Birmingham, Ala..38,415
Little Rock, Ark..38,307
Springfield, O......38,253
Galveston, Tex....37,789
Tacoma, Wash....37,714
Haverhill, Mass...37,175
Spokane, Wash....36,848
Terre Haute, Ind..36,673

Dubuque, Ia.......36,297
Quincy, Ill.........36,252
South Bend, Ind...35,999
Salem, Mass.......35,956
Johnstown, Pa....35,936
Elmira, N. Y......35,672
Allentown, Pa.....35,416
Davenport, Ia.....35 254
McKeesport, Pa...34,227
Springfield, Ill....34,159
Chelsea, Mass.....34,072
Chester, Pa........33,988
Malden, Mass......33,664
York, Pa...........33,654
Topeka, Kans.....33,608
Newton, Mass.....33,587
Sioux City, Ia......33,111
Bayonne, N. J......32,722
Knoxville, Tenn..32,637
Chattanooga, Ten.32,490
Schenectady, N. Y.31,682
Fitchburg. Mass...31,531
Superior City, Wis.31,091
Rockford, Ill......31,051
Taunton, Mass.....31,036
Joliet, Ill...........30,720
Canton, O..........30,667
Butte, Montana....30,470
Montgomery, Ala..30.346
Auburn, N. Y.....30,345
E. St. Louis, Ill....29,655
Sacramento, Cal ..29,282
Racine, Wis 29,102
La Crosse, Wis....28,895
Williamsport, Pa..28,757
Jacksonville, Fla..28,429
Newcastle, Pa.....28;339
Newport, Ky......28,301
Oshkosh, Wis.....28,284
Woonsocket, R. I..28,204
Pueblo, Col.........28,157
Atlantic City, N. J.27,838
Passaic, N. J........27,777
Bay City, Mich....27,628
Fort Worth, Tex..26,688
Lexington, Ky.....26,369
Gloucester, Mass..26,121
South Omaha, Neb 26,000
New Britian, Ct....25.998
Council Bluffs, Ia..25,802
Cedar Rapids, Ia..25,656
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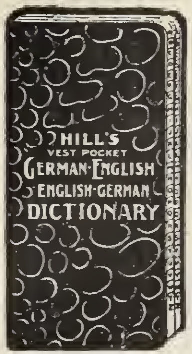

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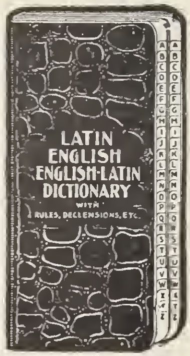

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"How to Teach" Manuals.—No. 6

HOW TO TEACH MINERALS

BY

FRANK OWEN PAYNE

AUTHOR OF "ONE HUNDRED LESSONS IN NATURE AROUND MY SCHOOL"

NEW YORK AND CHICAGO

E. L. KELLOGG & CO.

ROBERT DRUMMOND, PRINTER, NEW YORK

PREFACE.

IF the teacher is not familiar with minerals and desires to study them, a great deal may be done by procuring some minerals and a book. Study the former by the assistance of the latter. If possible begin this study by observing known specimens until thoroughly familiar with their qualities; such as hardness, color, streak, luster, fracture, cleavage, and the like.

Use your eyes diligently. The children will see what you see. Do not expect more of them.

Never be afraid to confess your ignorance of the name of a mineral. The most learned mineralogists often do so.

Correlate work on minerals with other work of the school. Thus sorting of minerals may be used as busy work with good results. Type forms of crystals may be made of paper or wire. This is form-study and manual training. Such models, and indeed many minerals, may be used as objects for drawing. In this way reading, writing, composition, drawing, manual training, and physical culture if an excursion be included, may all be made to contribute to this fascinating study.

MINERALS AND ROCKS.

CHAPTER I.

Outline of the Study.

SUBSTANCES are either organic or inorganic. They are also classified as belonging to three kingdoms, mineral, vegetable, and animal. Vegetable and animal substances are organic. Mineral substances are inorganic.

But all inorganic substances are not minerals. The gases—nitrogen, oxygen, hydrogen, chlorine, etc.—are inorganic, but they are not minerals. The substances sold at the drugstore, such as sal ammoniac, sugar of lead, blue vitriol, copperas, etc., are inorganic also, but they are not minerals either. They are *chemicals*. The remains of plants which once lived on the earth, but whose forms now are found imbedded in the rocks, are not minerals, although made up of mineral matter. They are *fossils*.

The crust of the earth consists of many materials. Each separate substance of which the earth's crust is made up is a *mineral*. Thus sand, clay, granite, shale, quartz, marble, mica, felspar, etc.,

are minerals. Minerals are made by natural processes. They were formed and are forming in nature without the aid of man. Such substances as glass, slag, phosphorus, brick, porcelain, and the like, are made directly or indirectly by man. Hence these are not minerals.

Where to Find Minerals.—The student of mineralogy sends away for rare specimens for study, but the beginner can do very well with minerals found close at home. Every sand-bank or gravel-pit is a mine from which many specimens may be taken, and the seashore abounds in pebbles which are made up of many kinds of minerals.

The writer once had a class in nature-study that found in one day's field excursion, in *less than an hour*, good specimens of glassy, smoky, milky, rose, yellow, red, and amethystine quartz, gneiss, granite, mica, feldspar, hornblend, pyrite, sandstone, and limestone—surely not a bad collection for so short a time and so limited a locality. Of course these specimens were not perfect crystals, but they were good enough for all practical work by school children.

It is advisable to begin *anywhere*, preferably where you happen to be, and study carefully the first minerals you see.

How to Study Them.—After having procured a specimen and having cleaned it—

Observe its form, color, etc., and determine answers to the following questions:

(1) Has it any definite geometrical shape?

(2) Is it granular, fibrous, etc.?

(3) Has it cleavage? If so, in how many planes?

(4) How does it reflect light? Does it appear greasy, glassy, silky, metallic, etc.?

(5) How does it feel? (harsh, soapy.)

(6) Does it taste?

(7) Does it smell?

(8) What is its color?

(9) What is its streak? To determine this, rub the specimen across a piece of ground glass or unglazed porcelain and observe the color of the mark (streak). These properties will be more fully described and explained later.

Apparatus.—Very little apparatus is needed for the study of minerals. The most essential things are the following: (1) a hammer, (2) a cold chisel, (3) a jack-knife, (4) a small bottle of hydrochloric acid, (5) a piece of ground glass or coarse unglazed porcelain, (6) a liberal supply of soft tissue-paper, and (7) a bag or small sachel in which to carry specimens.

FIG. 1.
Hammer.

The hammer should be small and made of hard steel. The head should be flat on one end and the corners square, while the other end should be very sharp.

Obtaining Minerals.—In making collections the following hints will be worth heeding:

1. Let each pupil provide himself with a box divided into compartments to receive the specimens of his own collection as soon as they are named.

2. So far as practicable let each pupil procure his specimens *for himself*. A collection made by one's self is more interesting and worth vastly more to the owner than one got by purchase or gift or exchange.

3. Minerals not to be had in the immediate vicinity can be purchased at low price from dealers.

4. Collectors in distant parts of the country are always glad to exchange specimens.

Labels.—No collection is worth much unless it is properly labeled. Each label should contain the following data: (*a*) Name of mineral; (*b*) where found.

If name be not known, the locality at least should be placed upon the label, and the name can be added at a later date.

Treatment of Specimens.—Great care should be observed in the treatment of specimens. It is for this purpose that the tissue-paper is needed to wrap up every specimen. If fragments of minerals be thrown hit-or-miss into a box or bag, they are apt to rub together and the softer ones become more or less injured by being scratched by the harder ones. In this way valuable specimens become seriously scratched.

So, for the same reason, when we come to study minerals, it is not wise to scratch one on its brightest surface. Such treatment mars the specimen beyond repair. In one's specimen case it is also well to have soft cotton lining each compartment. Choice specimens are sometimes utterly ruined by careless handling.

In collecting crystals it is always best to leave them with part of the surrounding stone (matrix) adhering. This shows the crystal in its environment.

The surrounding matrix should not be removed unless the crystal is absolutely perfect.

CHAPTER II.

Hints to Teachers.

As the teacher will need to learn something about minerals before he can teach them, he will begin by—

(1) Examining minerals carefully;

(2) Studying about them in books;

(3) Visiting museums and private collections; and by

(4) Conversing with people who understand them.

If the teacher has an interest in minerals, his pupils will *catch* it. Nothing is more contagious than enthusiasm in any subject, and such a study as this is specially "catching." Children like to collect things of any sort and all sorts. The various manias of the past such as collecting buttons, stamps, postmarks, etc., prove this.

It is unwise to attempt to force work in any sort of nature-study upon children. If the teacher is interested, his interest will awaken a similar interest in all his pupils. Beauty and variety in form, color, and luster of minerals will invariably awaken a lively interest among children. Forced work of

any kind in school is not the best kind. It is the spontaneous work which does the most good. For list of books relating to minerals, see sources of information in the Appendix.

CHAPTER III.

Crystals.

If some minerals be examined, they will be found to be built up of a great many regular solid forms having smooth faces. These regular solids are called crystals. They may be large or exceedingly small. The *size* is of no consequence. It is the *shape* of the faces and the *angles* between them that determine the kind of crystal.

Experiments.—Catch some snowflakes on a piece of black cloth. Examine them. They will be found to be in every case hexagons or modified hexagons (six-pointed stars or equiangular triangles). If thin plates of ice be examined in a dark room by means of light admitted through a small opening, these six-sided or stellate crystals may also be seen more or less deformed because of pressure of other crystals surrounding them.

Experiment.—Dissolve a teaspoonful of alum in a tablespoonful of boiling water. Let the solution cool and stand for a short time. On examination beautiful octahedral crystals will be found in the solution. If thread, grass, or feathers be im-

mersed in a solution of alum, they will soon become covered with these beautiful octahedra.

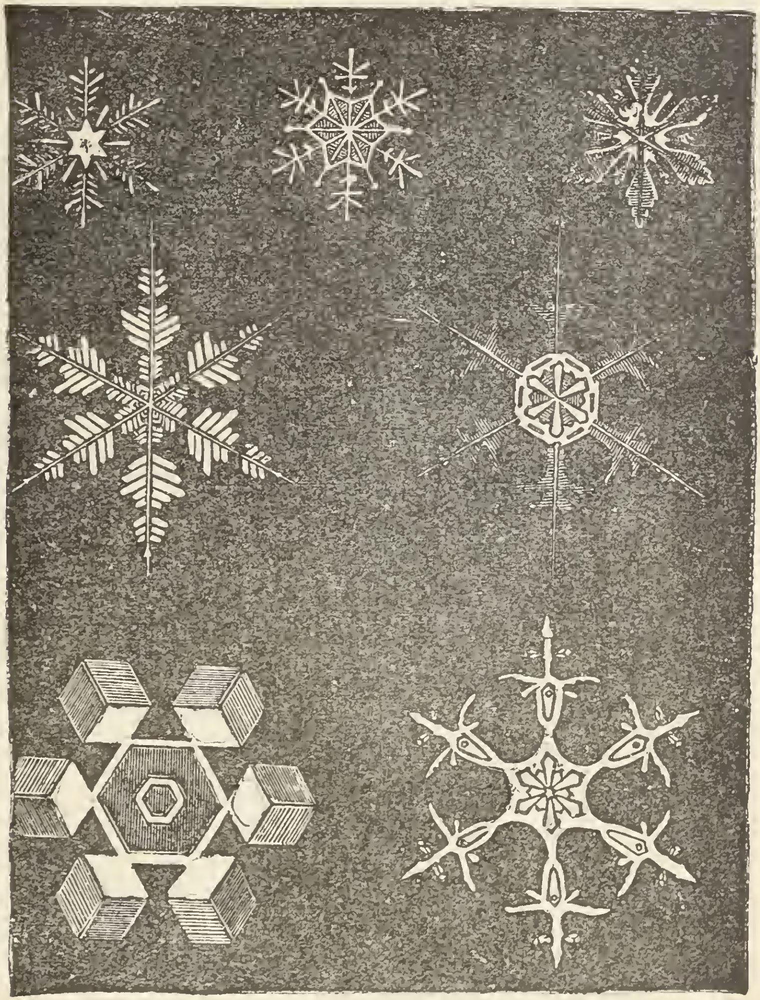

FIG. 2.—Snow-crystals. **For winter nature-study.**

Experiment.—Procure some "rock-candy" at a store. Examine the crystals and draw the most perfect. These are *monoclinic* crystals. Some of these substances are not minerals, but their crystals

are so easily obtained that I find this one of the very best ways to introduce the study of crystals to children. If it be desired to study crystals in this manner further, a few drops of solution of sugar of lead or sal ammoniac, or common salt or saltpeter, may be placed on slips of glass. When the liquid evaporates the crystals will be left upon the glass, where they may be studied under a magnifying-glass or with the naked eye.

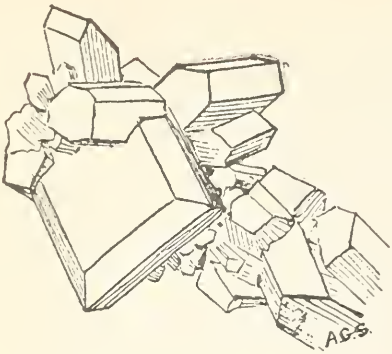

FIG. 3.—Rock-candy.

In nature, crystals are seldom if ever perfect, but they are frequently distorted owing to unequal development in different directions. The accompanying simple geometrical outlines represent types of crystalline form.

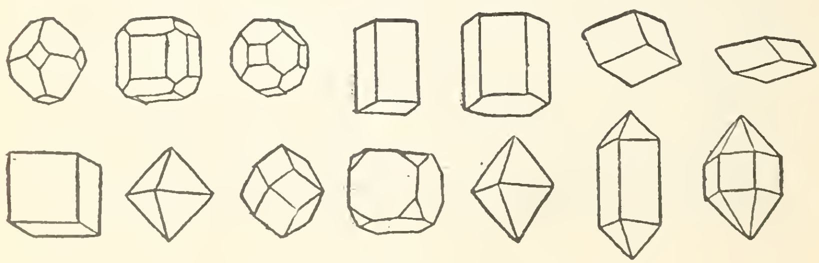

FIG. 4.—Forms of Crystals.

It is recommended that pupils construct figures out of wire or development paper to illustrate these crystalline forms.

In general it is true that if a crystal shows square faces, it belongs to a cubic type; if triangular faces, it is probably of the octahedral type; if rhombs, it is of the rhombic dodecahedral type. The subject of crystalline form is too difficult to take up in school. It may be well to note that crystals frequently appear in forms which are not simple solids, but combinations of two different forms.

Massive Minerals.—But all crystalline minerals do not show the crystalline form. Yet they are none the less crystalline. A piece of marble looks granular on a freshly broken surface. It is not unlike a piece of compact sandstone at first sight. But when the freshly broken surface is held in the light at an oblique angle, it will be seen that in some positions there will be sparkling points all over it. By turning the fragment around, another set of shining faces will be exposed. This shows that marble consists of many tiny crystals whose corresponding faces reflect the light because they are at the same angle.

Examine surfaces of freshly broken marble, granite, sandstone, slate, etc., and see which are truly crystalline. Bodies which are not crystalline are said to be amorphous. Sandstone will be found to be composed of small grains of sand firmly cemented together. But their irregular surfaces and the variable angle between them prove conclusively that they are not crystalline.

CHAPTER IV.

Properties of Minerals.

THERE are ten distinguishing properties of minerals. These are:

1. Cleavage.	6. Color.
2. Fracture.	7. Transparency.
3. Hardness.	8. Streak.
4. Feel or touch.	9. Fusibility.
5. Luster.	10. Taste and smell.

These properties need careful study since a mineral can be determined only by studying it as regards these characteristics.

1. **Cleavage.**—By cleavage is meant the way in which a mineral breaks. If a crystal of rock-candy be examined, it will be found that some of its faces are smoother than others. Some faces are as smooth as glass, reflecting the light as glass does when held at the critical angle. Other faces of the same crystal are duller or rougher. The smooth faces are invariably parallel to each other and the rougher ones are also parallel. The same is also true of other crystals. If a mineral be broken with a

smart hammer blow, it will be found to break more easily in some directions than in others. The reason for this seems to be because cohesion in some directions is stronger than in others. These planes, along which minerals break, are called *planes of cleavage*. Thus common salt shows three planes

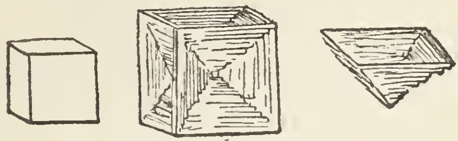

FIG. 5.—Salt.

of cleavage at right angles to each other, so that a crystal of common salt is a perfect cube.

2. **Fracture.**—By fracture is meant any peculiarity in the way bodies break other than along their planes of cleavage. Thus if a fragment of ice or glass or quartz be broken it usually shows a peculiar mark not unlike a shell, hence such form of fracture is called a *conchoidal* fracture. Indeed this form of breaking so closely resembles a shell that inexperienced pupils frequently mistake such fractures for fossil shells.

FIG. 6.—Conchoidal Fracture.

Look at the edge of a plate of thick glass. Many shell-like markings will be seen, A glass marble will also show these conchoidal fractures after it has been used for some time. The point where the blow was dealt forms the "beak' or "umbo" of

the shell and the lines of stress very nicely represent the *lines of growth* in this mimic shell. Other forms of fracture are called *splintery*, when the mineral breaks in splinters similar to the fracture of wood; *earthy*, etc, Break specimens of hard coal, soft coal, glass, brick, and various common stones. Examine the fracture and name it. Pitch, when cold, and sealing-wax, rosin, and other substances of like kind, often show very beautiful fractures.

3. **Hardness.**—This is the ability to resist scratching. It is a very important, perhaps the most important, property to be determined. Various minerals are taken as standards of hardness. They have been arranged by mineralogists in what is called the *scale of hardness*. This scale is represented as follows, graded from softest to hardest: 1. Talc (soapstone); 2. Gypsum; 3. Calcite; 4. Fluorite; 5. Apatite; 6. Orthoclase; 7. Quartz; 8. Topaz; 9. Corundum; 10. Diamond.

The last three are very rare and valuable. They need not often be used. The first seven minerals are very common and should be learned in their order. Each one will scratch all the others *below* it in the scale. A little practice with a penknife will easily enable one to determine the position of almost any mineral in the scale of hardness. Thus No. 1 feels soft and greasy to the hand. It will rub off on clothing, making a soft gray line. No 2 is easily scratched with the finger-nail. No. 3 can not be scratched with the finger-nail, but it can be

cut easily with the knife. No. 4 will not permit itself to be *cut* with a knife, but it may easily be *scratched* with the knife-blade. No. 5 is very hard to scratch with a knife-blade, but may be scratched slightly if considerable effort be made to scratch it. No. 6 will not be scratched at all with a knife, but it will itself scratch glass. No. 7 scratches glass easily.

4. **Feel or Touch.**—By the touch or feel of a mineral is meant the sensation arising from handling it. Thus a mineral may be said to have a harsh feel, a greasy feel, a rough feel, a satiny feel, etc., just as the hand may tell the difference between velvet, silk, sandpaper, flannel or brilliantine by the touch or feel of it. This property does not enter into the determination of very many minerals, but there are a few which have a very characteristic feel.

5. **Luster.**—The way a mineral reflects light has much to do with its nature. This is called its luster. Thus minerals are said to have a *metallic* luster if they resemble metals. Such a mineral is "Fool's-gold," which has a dull yellow color and metallic luster which make it closely resemble the "royal metal." In like manner minerals have a *glassy* or *vitreous* luster or *waxy*, *pearly*, or *silky* luster.

6. **Color.**—Color also is a quality which often proves very helpful in determining a mineral. Color alone is not sufficient to determine. Not all red stones are garnet, or ruby or bloodstone. Aside from beryl, ruby, turquoise, amethyst, emerald,

topaz, garnet, sapphire, and other precious stones, the common minerals are of various colors. Thus there are pink, red, yellow, white, purple, and gray varieties of quartz; and pink, cream, and white varieties of feldspar. Mica also varies in color from golden and almost colorless to dark brown and black.

7. **Transparency.**—By transparency is meant the ability of a mineral to transmit light. Thus a mineral may be *transparent* if it perfectly transmits the light, *translucent* if it permits the passage of part of the light and *opaque* if it permits the passage of no light at all. Of these, vitreous quartz is perfectly transparent. Smoky quartz and chalcedony are translucent. Fool's gold and hornblende are opaque.

Experiment.—Compare a glass tumbler or pane of window-glass with a china saucer and an earthen plate as to their transparency.

Another property closely allied to transparency and one which is found in only a few minerals of crystalline form is that of *double refraction.* Objects seen through one of these minerals invariably appear double. Iceland spar is such a mineral. This is due to the double refraction of the beam of light in its passage through the mineral. This property of light is imperfectly understood. Such crystals are called polarizers and may be studied more at length under polarized light.

8. **Streak.**—One of the most remarkable prop-

erties of some minerals is the fact that if rubbed across some hard rough surface like ground glass or unglazed porcelain, a streak or mark is left which usually differs very materially in color from the mineral itself.

Thus hematite may be dark brown or gray or even black in color, but the streak is invariably red.

9. **Fusibility.**—To determine this property the mineral should be placed on a piece of charcoal and the flame of a Bunsen burner or alcohol lamp should be directed upon it by means of a mouth blowpipe. This is not an essential test for beginners and teachers are recommended not to try it unless they desire to go much further into the study than is proposed in this book.

FIG. 7.
Blowpipe.

To use the blowpipe intelligently one must needs have a thorough course in chemistry, including practical work in blowpipe analysis.

10. **Taste and Smell.**—Only those minerals have taste which are soluble in water. Thus there are comparatively few which have a characteristic taste. Those which have any taste are not hard to describe. They are saline, alkaline, bitter, sour, astringent, sweetish, cooling, etc.

In regard to smell they may be fetid, clayey, sulphurous, garlicky, etc. Minerals containing sulphur give off fumes of hydrogen sulphide (H_2S)

gas when acted upon by the air. This gas has the characteristic odor of rotten eggs. Some sulphides when hit a smart blow with a hammer will give off fumes of sulphur dioxide (SO_2) gas, the familiar smell of burning matches. Clay shales and slate emit the peculiar odor called above "clayey," and minerals containing arsenic give off the odor of garlic when hit with a hammer.

CHAPTER V.

Special Features of Some Minerals.

CLEAVAGE has been defined as "easy fracture in certain directions." But when the mineral has been broken, the exposed surface is not always the same in appearance.

Cleavable minerals may be of four classes:

(*a*) Coarse-granular; (*c*) Compact;
(*b*) Fine-granular; (*d*) Impalpable.

These differences depend on the coarseness or fineness of the grains exposed In the coarse-granular variety the grains are easily seen with the unaided eye, but in the impalpable they are so fine as to be indistinguishable with the naked eye. To make these distinctions clear to a child, four bottles may be taken, the first full of coarse sand or fine shot, the second full of fine sifted sand, the third containing clay, and the fourth fine flour or lycopodium powder. Some of each, when rubbed between the fingers or even when examined with the eye, will give the impression of the corresponding surface appearance in a mineral.

Still another classification of minerals has reference to the peculiarities in structure of the entire mass. A mass of selenite or mica is found to be composed of thin separable plates. These are so thin as to be easily separated with a knife-blade. Other minerals are composed of needles, columns, fibers, etc. The principal forms in which masses of minerals are arranged are as follows:

(*a*) Plates (lamellar);
(*b*) Thin leaves (foliated);
(*c*) Very thin leaves (micaceous);
(*d*) Columns (columnar);
(*e*) Needles (acicular);
(*f*) Fibers (fibrous);
(*g*) Rays (radiate);
(*h*) Stars (stellate);
(*i*) Rings (concentric).

Graphite (stove polish) is foliate; trap-rock and basalt are columnar; asbestos is fibrous; snow is stellate; malachite is concentric.

External Form.—Mineral masses also vary greatly as to their external appearance. Some have the appearance of spheres all fused together in a mass. If these spheres are large and almost separate the form is known as *mammillary;* if the mass is composed of smaller spheres so that the whole mass somewhat resembles a cluster of grapes, the form is called *botryoidal.* If the spheres are very prominent, so as to stand out from the mass in quite

high relief, the form is said to be *globular*, and if the rounded masses are more nearly flat or elliptical in outline, they are called reniform. Beautiful reniform masses of hematite are found among the iron regions of Minnesota and Michigan.

CHAPTER VI.

Mineral Description.

In description of minerals the pupil should have a blank book or plenty of blank paper for that purpose. A good order of description is the following:

1. Cleavage.
2. Hardness.
3. Weight (relative).
4. Luster.
5. Color.
6. Streak.
7. Transparency.
8. Other characteristics.
9. Chemical properties.

The following table is given for use of those who desire a fuller outline for descriptions of minerals:

[*Name of Mineral.*]

(Date of study,.................................. Time employed,........ .)

Hardness ....

Form..

....

Structure ....

....

Cleavage. . . . .

. . . .

Fracture. . . . .

Tenacity. . . . .

. . . .

Color. . . . .

Streak. . . . .

Luster. . . . .

Diaphaneity. . . . .

. . . .

Touch. . . . .

Magnet. Electricity. . . . .

Weight, Sp. G. . . . .

Chemical Properties . . . .

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Composition . . . .

Formula.................... ....

Classification..............................

Characteristic tests ....

Varieties..................................

Uses; Element of Value, how extracted; Natural History.

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The above complete outline for mineral study is taken from a most excellent little book on minerals, written and printed by Prof. Miner H. Paddock of Providence, Rhode Island, entitled "Minerals in the Public Schools."

CHAPTER VII.

General Lessons for Little Children.

1. **Primary Lessons.**—*Common mineral* substances, such as the metals iron, copper, lead, zinc, brass, nickel, silver, tin, and salt, sulphur, quartz, sandstone should be given to the children to handle.

Perhaps the *sorting* of such things is the best way to get the children to handle them. The supplies needed for this work are easily procured. Iron may be studied from nails, wire, pieces of sheet iron and cast iron. Copper, lead, brass, etc., may be handled in a similar manner. Even articles of silver and gold are not hard to get for such work. The greater the variety, the better.

If a child fails to get all things of a kind together, lead him to discover his error by questioning him, not by telling him. Let there be many lessons of this kind.

2. **Secondary Lessons.**—*Rocks* may next be studied. Let this work be similar in scope and character. Procure specimens of sandstone, limestone, conglomerate, slate, granite, marble, hard coal, pumice stone, etc. Let there be as many

sorts as possible of each kind, as red sandstone, white sandstone, gray sandstone, red and gray granites, and the like.

Before giving to pupils for study, place on the under side (poorest side) of each fragment a small bit of paper with corresponding number, but no name. Thus all the red sandstone will be No. 1, and all the limestone, No. 2, etc. Let these minerals be sorted as before, only applying other tests than those used on the metals. How do they *taste*, *smell*, *break*, *scratch*, etc.?

3. **Later Lessons.**—*Pebbles*, to teach something of the forces at work to change minerals.

Let the pebbles be rolled up in tissue-paper so as to cover them. Observe the weight, smell, size, shape, taste, etc., without seeing the pebble. Note color, form, structure, etc.

Inquire how the pebble became *rounded*. A good way to illustrate how this happened—and certainly not a disagreeable one—is to give each pupil a rough, angular piece of candy or sugar. Let each place his candy in the mouth and roll it about it for a few moments. Then look at it and the corners and angles will be seen to have disappeared.

Suppose a rough and jagged rock be rolled about like this by the waves upon a rocky shore, what effect will it have on the edges of the rock?

Show that waves, currents of streams, waterfalls, etc., are constantly rolling the stones about; in this way they become smooth and round.

Bring out the fact that it is a very slow process, taking years upon years to do the work.

Every pebble is therefore *very old.* Its history is very interesting. It involves the work of frost, roots of plants, or other agencies which split up the original stone into irregular pieces; the glacier and the wave may have had a part in its polishing. Such thoughts offer a fine opportunity for language work.

CHAPTER VIII.

Lessons on Minerals.

I. SULPHUR.

Preparation.—Procure pieces of brimstone or roll sulphur, flowers of sulphur, or sublimed sulphur; also, a small bottle of carbonic bisulphide.

Talk about sulphur, where it comes from (volcanic regions) and its various uses, such as the manufacture of matches, gunpowder, vulcanite (hard rubber), acids, sulphuric acid, etc.

Presentation.—Having given a small piece to each pupil, endeavor to bring out the following facts by means of observations:

(*a*) cleavage (irregular);
(*b*) hardness ($1\frac{1}{2}$—$2\frac{1}{2}$);
(*c*) weight (not very heavy);
(*d*) luster (resinous);
(*e*) color (light canary-yellow);
(*f*) streak (yellow);
(*g*) transparency (opaque);
(*h*) Other characteristics (brittle, sectile, tasteless, melts, burns with blue flame, emits a suffo-

cating gas in burning). This gas is a bleaching agent.

(*i*) Crystals (octahedral and prismatic).

Note. To obtain all these crystals, dissolve a small portion of powdered sulphur in a little of the carbon bisulphide and pour it out into a shallow dish. Presently there will form beautiful octahedra of clear transparent yellow color, like amber jewels from a ring.

The prismatic crystals may be obtained by melting a few ounces of sulphur and just as it begins to cool, tip the vessel and pour out the molten part. Beautiful needles or prisms will be seen projecting towards the center of the dish.

Under the microscope these needles are seen to be made up of octahedra placed in line.

Association and Comparison.—Compare sulphur with other familiar substances as regards these properties. Do this at a later date than that on which the lesson is given. This serves to re-present sulphur.

Generalization.—What other things burn? Do all substances burn? Crystallize? Some things leave a streak on ground glass. Some melted substances form crystals when they cool. Water does so.

Application.—Read about the manufacture of gunpowder, of its invention, of its first introduction into Europe. Read about "Greek fire;" also accounts of Vesuvius and other volcanos. De-

scribe the process of making matches and read selections about the use of flint and tinder before matches were made. Study about Goodyear and the invention of vulcanizing rubber; the employment of rubber in articles of daily use, etc.

Old superstitions concerning sulphur as an evil agent may not be omitted, and passages from Milton and Dante might be selected for reading by pupils of maturer years.

2. GALENA.

Follow the same plan as outlined in the lessons on sulphur. Galena is a common ore of lead. If found at hand use it; if not, omit it.

A study of galena ought to bring out the following facts :

Color bluish gray.

Luster metallic.

Crystal cubes or octahedra.

Hardness 2½.

Weight very heavy, as are all the compounds of lead.

Freshly broken surface tarnishes very quickly.

Uses, as a source of the metal lead. Also in making glass and glazing pottery.

Experiment.—Heat a small portion on a piece of charcoal by means of a mouth blowpipe. A small globule of lead will soon be formed.

Correlations.—Study the lead regions of the

United States, Northern Illinois, Southern Wisconsin, Eastern Iowa, Colorado, etc.

Where are Galena and Leadville ?

3. PYRITE —"FOOL'S-GOLD."

This is such a common mineral that every child can obtain it.

Pyrite is an iron ore, being composed iron and sulphur. To prove this, pulverize a little and place in a piece of glass tubing or small test-tube. Heat in alcohol or gas flame and sulphur will pass off and condense in the cool part of the tube. Only part of the sulphur will pass off.

A study of pyrite will disclose the following facts:

Color yellowish or brassy golden.

Crystals.—Cubes or dodecahedra having numerous fine lines crossing them.

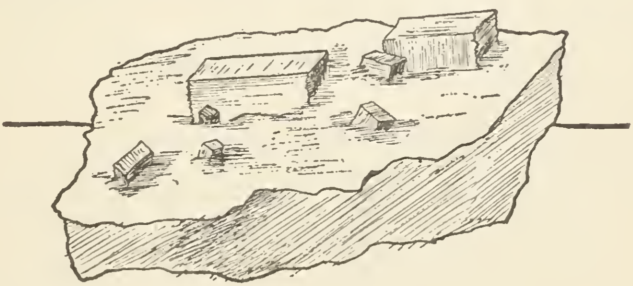

FIG. 8.—Pyrites.

Hardness 6 +. I.e., it scratches glass, but a knife does not scratch it.

Streak greenish black.

Experiment.—Strike it with a piece of steel. Sparks fly. Hence the name *pyr-ite*.

Another form of pyrite is known as white pyrites. It often takes very beautiful forms but it is not so permanent as the yellow variety. It weathers, changing into a white powder.

Correlations.—Read from the history of the Virginia colony how the settlers sent home a ship-load of pyrite to England thinking it to have been gold.

Make a list of words containing the syllable *pyr;* such as pyrite, pyrotechnic, pyramid, pyre, pyrography, etc. Which of these contain the idea of *fire ?*

Study the etymology of the word *bureau* in the same connection.

4. HEMATITE (IRON ORE).

Hematite can be obtained from iron mines and often along railroad tracks where it has fallen from cars in transit.

Color varies from black to reddish.

Luster metallic.

Streak invariably red; hence its name.

Fracture various; some kinds have a conchoidal fracture and a reniform surface.

Some iron ores are magnetic, but hematite is not.

Study the process of reduction of iron ores. Assign topics like the following for research: Bessemer process of making steel; the manufacture of cast-iron, wrought iron, nickel-steel; the iron regions of the United States; Russia iron and Swedish iron, galvanized iron.

5. CALCITE (LIMESTONE).

The different forms of limestone are so varied as to be hardly recognizable for the same substance.

A good test is to put a drop of hydrochloric (muriatic) acid on thc suspected mineral and if it effervesces it is almost certain to be a limestone.

Color.—Varied from pure white as in Carara marble to jet black in Egyptian marble and beautifully mottled as are some of the Grecian and Italian maibles.

Crystals are also various.

Hardness about 3.

Luster various, as glassy, silky, satiny, dull, etc.

Some species are used for making lime, others for building, others for statuary, etc.

Suggestion.—Procure specimens of marble from a marble-cutter, and apply all the tests to each specimen.

Correlations.—Read about Mt. Pentelicus in Anthon's Classical Dictionary and elsewhere. Examine pictures and casts of famous statues. Study about the manufacture of lime from limestone.

6. HALITE (ROCKSALT).

Rock salt may be had at any store where stock-foods are kept. It is abundant in three forms. These are massive halite which is sold in large

lumps; coarse salt used in cream freezing; and table salt.

Rock salt is a peculiar mineral in this that it is very soluble in water.

Color.—The massive form varies from gray to yellow and red, due to impurities. Some specimens have been found having a clear blue color. The other varieties are white or clear like glass.

Crystals.—These are perfect cubes, but in coarse salt these cubes often arrange themselves in the form of hoppers; hence they are called "hopper-shaped" crystals.

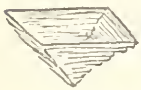

FIG. 9.

Cleavage in three planes at right angles; hence called cubic cleavage.

Hardness 2½.

Weight heavy, about twice as heavy as water.

Luster vitreous-glassy.

Experiment.—Heat a little salt in a flame, it gives an intense yellow color due to the presence of sodium.

Occurrence.—Mines in various parts of Europe; springs in central New York; wells in Ohio, Indiana, etc.; bodies of salt-water, as Great Salt Lake, Dead, Caspian, and Aral Seas, and the ocean.

Correlations.—Read about salt mines of Austria, salt industry at Syracuse, N. Y., and Sanginaw, Mich. Write on the importance of salt in food. Etymology of such words as salary, salsify, saline, salvation, etc.

7. QUARTZ.

Quartz is the commonest and most varied of minerals. It is not abundant everywhere in the crystalline form, but in the form of rounded pebbles it is everywhere to be had.

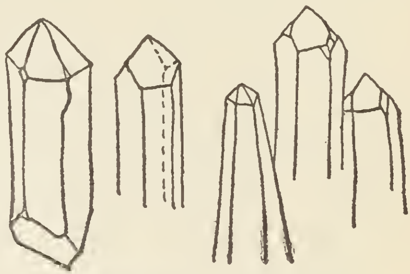
FIG. 10.—Quartz.

The beginner can find good specimens of the following varieties in a short walk: clear (vitreous or glassy), milky, smoky, yellow, red, and sometimes rose (pink) and amethystine (pale violet).

Gravel-pits, sand-banks, and the seashore are excellent spots for collecting quartz.

Crystals.—These are invariably six-sided prisms, usually tipped with six-sided pyramids.

Fracture conchoidal.

Luster glassy.

Hardness 7; i.e., it easily scratches glass, but cannot be scratched by a knife. *Always* be sure to test a specimen for *hardness* before pronouncing it to be quartz.

Varieties.—Besides those enumerated above may be mentioned agate, chalcedony, onyx, carnelian, flint, jasper, sardonyx, opal, and many more. Sandstone and quartzite are compact forms of quartz.

Suggestion.—It is very interesting to boys to

polish off one side of a pebble, so as to see how it looks when dressed. To do this, procure three grades of emery-powder and mix a little of each with oil. Put some of the mixture on a plate of thick glass and, holding the pebble firmly, rub it back and forth until one side is smooth. Having done this with the coarsest emery, do the same thing with a finer grade, and, last of all, finish by rubbing with the finest. Water may be used instead of oil, and a grindstone may be used instead of the emery-powder, if one is not in a hurry.

Specimen pebbles show off best if they are broken on one side to show fracture, and polished on the other to bring out color, luster, etc.

Quartz is not always easily identified, owing to its many varieties.

8. MICA.

For work on this mineral alone, procure a piece of so-called "isinglass," used in stove windows and doors, and examine it.

Color brown, when several thicknesses are held together.

Cleavage.—Split by inserting the edge of a knife-blade. This is what is called perfect basal cleavage. There is no limit to this splitting.

Transparency.—Thin layers are perfectly transparent.

Crystals.—To determine the shape of crystals,

take a rather thick piece of mica and lay it on a table. Take a nail-set or blunt piece of iron and place it over the center of the piece of mica. Then hit the nail-set with a hammer a smart blow. Now examine the mica by looking through it. A small six-pointed star will be seen formed by three lines which intersect at a point making angles of 60° with each other. This shows that the original mica crystals are either equilateral triangles or rhombs 60°–120°, or regular hexagons.

FIG. 11.—Mica star.

9. GYPSUM.

There are four principal forms in which this mineral occurs. These are alabaster, selenite, satin-spar, and rock-gypsum. All these are of the same chemical composition, being sulphate of calcium, but these four forms are so varied that a more extended description is necessary. *Alabaster* is of a fine compact structure, usually pure white, though sometimes more or less mottled and streaked like agate. If heated to a high degree, it loses most of its water of crystallization and changes to a white powder resembling flour. This is called plaster of Paris, used extensively in making casts, etc., because when it is mixed with an equal bulk of water it hardens almost immediately. Many beautiful

experiments may be made with plaster of Paris. Casts of hands, faces, fruit, vegetables, and many other objects may be made by pupils while studying gypsum. Its great value in the arts cannot be exaggerated. All forms of it may be reduced to powder by heating and then grinding, after which it is extensively used for making images, busts, vases, molds, casts of statues, and coins and medals, picture-frames, cornices, repoussé decorations of walls and ceilings, and hard finish for walls of rooms. It is also used by the farmer as a fertilizer, and by the dentist in making sets of false teeth. Alabaster is easily cut with a knife, hence it is extensively used for carving vases and statuettes. Selenite is transparent and of a laminated structure; satin-spar is fibrous; and rock-gypsum is coarse and granular.

10. SERPENTINE.

Serpentine may be known by its green color and waxy or greasy luster. Its color is not constant or uniform but varies from a dull apple-green to a semitransparent citrine color. It is also variously mottled and streaked. Its hardness is about 3, sometimes a little above and sometimes slightly below that figure in the scale of hardness.

If powdered and heated in a closed tube, about one-tenth of its weight of water will be given off.

The name serpentine comes from the peculiar

cloudings and markings of some varieties of this mineral. There are several varieties, among which are *chrysotile* or golden fibrous serpentine, which is sometimes mistaken for asbestos because of its fibrous structure. The most beautiful variety is known as *verd-antique* marble. This is not pure serpentine but a mixture of that mineral with calcium carbonate. Verd-antique is susceptible of a high polish and is extensively used for making table-tops, mantels, articles of vertu, and all forms of inside work. It is not good for out-door work on account of its weathering in the open air. It may be turned in a lathe.

Beautiful specimens are found in many parts of the United States. Massachusetts, Vermont, New Jersey, New York, and other Eastern States have valuable quarries of this beautiful mineral. In Philadelphia and in Baltimore many buildings are built of a dark green variety. So common is this building-stone in and about Philadelphia that it is known in many parts of the country as "Philadelphia green-stone."

CHAPTER IX.

Rocks.

I. GRANITE—GNEISS.

THE hunter for minerals will often find bowlders and pebbles varying from a few ounces to many tons weight, which seem to be made up of two or three constituents.

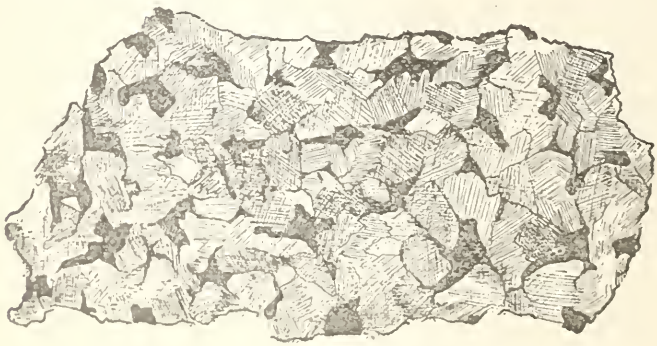

FIG. 12.—Polished Surface of Granite.

A freshly broken surface will usually show clear spots (quartz), and spots of white, pink, red or black (feldspar), and numerous shining golden points (mica). If the mica is in layers so that the rock can split, it is gneiss; but if the three ingredients are thoroughly mixed, it is called granite. The

granites vary greatly in the amount of materials composing them. Some granites have hardly a trace of mica. These are best for building purposes, because the mica weathers out leaving holes in the surface. Examine the surface of a granite monument in some cemetery.

Granites also vary greatly in the size of pieces of each ingredient. Specimens may be found in which the masses of quartz, feldspar, and mica are so large as to be easily separated from each other.

The feldspar may be of several varieties, but a work so elementary as this can not go into this subject more in detail. The two principal kinds of feldspar are *orthoclase* so-called because all its planes of cleavage are at right angles; and *albite*, so-called because of its white color. Any dealer in gravestones and monuments will give one many specimens of granite, if asked for them.

* DESCRIPTION. EVA THAYER.

"My specimen has three kinds of materials in it. The first is smooth and glassy, and will scale off in your hand. It is not very hard, and it looks like isinglass, but that is not its name. It will not scratch glass, and I think it is mica.

"The second mineral is dark grayish in some places, and light grayish in others. It is quite

* These two excellent descriptions of specimens of granite are the work of pupils quoted from Henry Lincoln Clapp's admirable little book entitled, "Thirty-six Observation Lessons on Common Minerals," published by D. C. Heath & Co., being No. XV. of their *Guides for Science Teaching*.

hard, and will scratch glass. It looks like rock salt with little pieces of dark mineral in it, and I think it is smoky quartz.

"There is one mineral in the specimen, which is white and hard, and will scratch glass.

"The whole piece is some kind of granite, but I do not know what kind."

*** DESCRIPTION.** **EBEN VAN TASSEL.**

"There are three minerals in this specimen. The feldspar will scratch glass, and the color of it is pink and white. The quartz also will scratch glass, but the mica will not.

"The mica is used for stove doors. If you take your knife to the mica, it will come off in layers. Some people call it isinglass, but it is mica. I think the quartz is the hardest, and the mica the softest. I do not know the name of my specimen. They build houses and stone walls with it, and we use it for steps, pavements, and underpinnings for houses. You can find these minerals in Franklin Park if you look for them. I do not know any more about the subject."

2. SANDSTONE, QUARTZITE, ETC.

This rock is made of sand; i.e. it was probably sand, and owing to great pressure and perhaps heat, the sand grains were cemented together. There are many sorts due to differences in color,

size of granules, and cohesion of particles. Some of the commonest varieties are compact, friable, gritty, siliceous, micaceous, massive, flexible, laminated and any many others.

Quartite is a metamorphic sandstone, i.e., one usually of fine grain which has been heated and so cemented as to be exceedingly hard.

Sandstones are very various in color. There are white, gray, yellow, brown, red, and various mottled kinds.

Conglomerate consists of fine grain stone in which are imbedded pebbles of various sizes. The com-

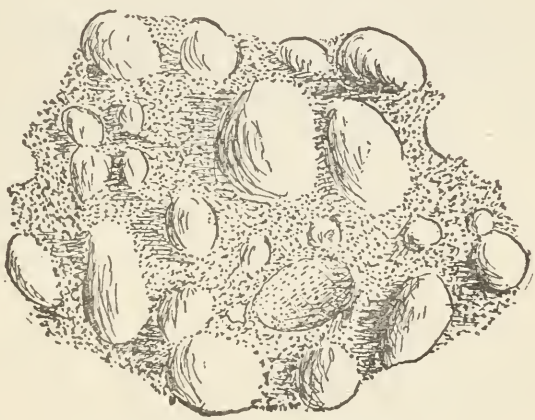

FIG. 13.—Conglomerate.

monest conglomerate is gray containing white quartz pebbles. In some localities the matrix is of a beautiful purple color containing pebbles of various colors mostly white.

This variety of conglomerate is called "pudding stone," because the imbedded pebbles remind one of fruit in a pudding.

Sand and Gravel are rock just as much as are the solid masses of stone commonly called by that name. Common sand is almost wholly ground up quartz. Just how this has been accomplished belongs to the geologist to tell. But frost, glacial action, vulcanism, and action of waves have doubtless had much to do with its formation. Gravel consists of pebbles of various minerals and of various sizes, mixed with coarse and fine sand.

3. LIMESTONE.

The crystalline limestones were spoken of in the previous chapter.

Ordinary limestone is calcium carbonate and may be recognized by using a drop of hydrochloric acid. There will always be a brisk effervescence, because carbonic acid is given off. Close examination will usually show multitudes of fossil shells. Chalk is a stone having the same chemical composition as limestone, i.e., calcium carbonate, but it is much softer and will mark on the wall. It is not common, and the ordinary school crayons are not chalk as they are usually called. Crayons are made largely of plaster of Paris. Chalk under the microscope is seen to be made up of innumerable minute fossil shells.

Correlations.—Study about quarrying, burning lime, slacking lime, making mortar, etc.

4. CLAY.

Clay does not usually occur pure, but is generally mixed with more or less sand and feldspar. It is found in beds often of great extent.

The purest clay is kaolin, used in manufacture of earthenware. Clays vary in color from pure white to yellow, gray, blue, and deep dull red.

Clay, when dry, has a soft, almost velvety, feel; when wet it is sticky and very plastic. Hence its employment as a medium for modeling. Breathe upon clay and smell of it. There is an odor peculiar to it. This same smell is to be noticed with all substances like clay, such as shale and slate.

Correlations.—Study about modeling, porcelain manufacture, pottery. Read Longfellow's "Keramos."

Study about the manufacture of sewer-pipe, stoneware, brick, etc. Write biographical sketches of such men as Wedgwood, Palissy, etc. Learn something about the world's great potteries, i.e., Sevrès, Limoges, Royal Worcester, Rookwood, etc., etc.

CHAPTER X.

A Course of Study of Minerals.

THE following course in minerals is modified from Howe's "Systematic Science Teaching," edited by William T. Harris.

FIRST YEAR.

Sorting of metals, twelve written lessons. Other seasons are reserved for work on seeds, buds, fruits, stars, and domestic animals.

SECOND YEAR.

Sorting of minerals, fifteen winter lessons. Other seasons same as first year.

THIRD YEAR.

Sorting of minerals and rocks, fifteen winter lessons. Pebbles, thirty lessons. Other seasons as before.

FOURTH YEAR.

Twenty-five winter lessons on sharp stones, introducing the action of frost. Other seasons devoted to other themes.

FIFTH YEAR.

Twenty winter lessons on metals, with somewhat of their production and commercial importance.

SIXTH YEAR.

Sixty lessons on minerals, with special reference to molecules. Crystals.

SEVENTH YEAR.

Twenty-five winter lessons on crystals. Forty lessons on minerals. The blowpipe.

EIGHTH YEAR.

Ten winter lessons on coins. Forty lessons on earth-making. Rocks—Building stones.

Mineral study is here placed in winter because other material for nature-study is comparatively scarce at that season of the year, because minerals are easily studied indoors, and because they will keep.

Unlike plants and animals, minerals require no preparation and no preserving fluid. They are ready at all times. Spring is the time for growing things, autumn for fruits and flowers, but winter seems specially suited to the study of minerals and rocks.

CHAPTER XI.

Hints on Dressing Down Stones for a Cabinet Collection.

MOST pebbles and many fragments of stone do not show their greatest beauty unless one face at least is dressed down smooth.

This is often a long, hard, painstaking task if the stone be hard, but it never fails to pay for all the labor required.

To polish a pebble, first procure a plate of thick glass or a common heavy earthen plate and sprinkle upon it some coarse emery powder and a little oil. Then take the pebble which is desired to be polished and lay it upon the plate, moving it back and forth.

When the face has been smoothed somewhat, repeat the operation, using finer emery and fresh oil.

Complete the operation by using the finest grade of emery powder.

This process will give to every pebble so treated, a smooth, glassy, brilliant surface, which will show up every line and vein in the pebble, often bringing out beauties of color and marking of which the rough outside gave no hint.

Boys once interested in the art of dressing pebbles, become very enthusiastic over it.

APPENDIX.

LITERATURE.

THE following books will be found very helpful in the study of minerals:

THIRTY-SIX OBSERVATIONS ON COMMON MINERALS, by Henry Lincoln Clapp. Heath & Co.

COMMON MINERALS AND ROCKS, by William O. Crosby. Heath & Co.

MINERALS, AND HOW TO STUDY THEM, by E. S. Dana. John Wiley & Sons.

DESCRIPTIVE MINERALOGY, by E. S. Dana.

TEXT-BOOK OF MINERALOGY, by E. S. Dana.

MINERALS IN THE PUBLIC SCHOOLS, by Miner H. Paddock.

MINERALOGY AND PETROGRAPHY, by J. D. Dana. Wiley & Sons.

LITHOLOGICAL GEOLOGY (2d Chapter of "Manual of Geology"), by J. D. Dana.

MANUAL OF MINERALOGY, *ibid.*

SYSTEM OF MINERALOGY, *ibid.*

CRYSTALLOGRAPHY (Bulletin of Smithsonian Institute).

SYSTEMATIC SCIENCE TEACHING, by Howe. D. Appleton.

DETERMINATIVE MINERALOGY, by Brush.

NATURE STUDY, by Jackman. Holt & Co.

STATE GEOLOGICAL SURVEYS of New Jersey, Minnesota, Pennsylvania, and New York.

ELEMENTS OF CRYSTALLOGRAPHY, by G. H. Williams.

TREATISE ON METALLURGY, by Bauerman.
DIAMONDS AND PRECIOUS STONES, by Emanuel.
CRYSTALLOGRAPHY, WITH APPLICATIONS TO MINERALOGY, by J. J. Griffin.
NATURAL HISTORY OF PRECIOUS STONES, by C. W. King.
ROCK-MAKING MINERALS, by H. Rosenbusch.
ROCKS AND SOILS, by H. E. Stockbridge.
ABOUT PEBBLES, by Hyatt. D. C. Heath & Co.
ELEMENTS OF GEOLOGY, by Jos. Le Conte.
TEXT-BOOK OF GEOLOGY, by A. Geikie.
FIRST LESSONS IN MINERALS, by E. Richards.
FIRST BOOK OF GEOLOGY, by Shaler.
APPLIED GEOLOGY, by S. G. Williams.
GRAMMAR-SCHOOL MINERALOGY, HIGH-SCHOOL STUDENTS' MANUAL, and HIGH-SCHOOL MINERALOGY, by Miner H. Paddock.

Some of the above are rare and expensive, and can be found only in large libraries, but the majority are inexpensive and within the reach of all.

THE TEACHER'S CABINET.

It is very necessary that the teacher have a collection of his own. This collection should be as large and as varied as possible. The teacher who knows minerals and wants to teach them will easily collect his own specimens.

How to Get It.—But the teacher who is not familiar with minerals had better provide himself with a collection of typical specimens. These should be numbered and named so that they may be used for reference at any time.

Such collections may be purchased at small cost. Having purchased such a set of specimens and a book on how to study minerals, begin the book and refer to the collection as the study proceeds.

How to Keep It.—As soon as a collection has begun to grow, some place to keep it will become necessary. An old bookcase is excellent, if one can be found. A small show-case is good for the display of specimens, if there is space for such a thing. But many will find it necessary to make other arrangements for the accommodation of a cabinet.

One writer has adopted the following plan: He

procures several soap-boxes (21 in. × 15 in. × 9 in.) of equal size, and nails on the covers, also nailing all parts of the boxes firmly together. Then, with a saw, these boxes are cut into halves, thus being converted into trays, each 21 in. × 15 in. × 4½ in. These box-trays may be smoothed with a plane and either stained or varnished on the outside. Then they are placed in a pile, and on the outside of each tray is a label giving its contents.

Another plan is to procure a large number of cigar-boxes of the same size. Put specimens in these, and place labels on the ends of the boxes. These are very convenient, since each particular specimen can be taken away without interfering with the others, and the collection can be moved about with the least possible trouble. In any case the utmost care should be taken to protect valuable specimens from injury.

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16. Lang's Basedow: his Life and Educational Work
17. Lang's Comenius: " " " "
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19. Allen's Historic Outlines of Education
20. Phelps's Life of David P. Page
21. Lang's Rousseau and his Emile
22. Lang's Horace Mann: his Life and Educational Work
23. Rooper's The Child: his Studies and Occupations
24. Rooper's Drawing in Infant Schools
25. Dewey's Educational Creed

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HOW TO CELEBRATE

ARBOR DAY

IN THE SCHOOL-ROOM.

GIVING THE ORIGIN OF ARBOR DAY, HINTS ON THE PLANTING OF TREES, SPECIAL EXERCISES, ROSE DRILL, RECITATIONS AND SONGS, AND FIFTY QUOTATIONS.

FOR THE PRIMARY, GRAMMAR, AND HIGH SCHOOL.

EDITED BY

ALICE M. KELLOGG.

NEW YORK AND CHICAGO:

E. L. KELLOGG & CO.

CONTENTS.

HOW ARBOR DAY BEGAN.

As a day set apart for a special purpose, Arbor Day began its glorious existence with the planting of twelve millions of trees in Nebraska on April 22d, 1872. Since then over four hundred millions of trees have been planted by schoolchildren in that State alone. Kansas was the next to proclaim an Arbor Day, and Indiana and Pennsylvania were so pleased with the plan that they instituted both a spring and autumn holiday for tree-planting.

The Governor of Illinois in 1889, in his proclamation, said: "Let the children in our schools, the young men and women in our colleges, seminaries, and universities, with their instructors, co-operate in the proper observance of the day by planting shrubs, vines, and trees that will beautify the home, adorn the public grounds, add wealth to the State, and thereby increase the comfort and happiness of the people."

In Maryland about five thousand trees are planted each year. In New York the law provides that the Superintendent of Public Instruction shall prescribe and publish a course of Arbor Day exercises to be observed in all the schools on the third of May.

In different manner and degree, all over the Union, Arbor Day is marked with a red letter in the school calendar. Tree-planting is not always possible; next best is the planting of shrubs and flowers, if only an ivy or a window-box of seeds.

Arbor Day furnishes an opportunity for teaching children many valuable lessons, for introducing them in a delightful way to the beauties of nature, and for interesting them in the study of plant life. It is fast becoming one of the most instructive and delightful festivals of the school year.

Arbor Day is fulfilling a grand work, not alone in making school grounds beautiful and by replenishing the decayed and despoiled shade and forest trees, but by interesting the growing generation in nature and brightening the routine of school life with pleasant exercises.

HINTS ON PLANTING THE TREES.

To make a success of the tree-planting on Arbor Day, several things must be looked after.

First, the location. The trees should not be planted too near houses, nor too near to each other.

Second, the selection. Choose trees least liable to suffer from injuries; avoid root-spreading trees; choose those that bud early in the spring; do not attempt to transplant a tree more than fifteen feet high; choose one that has an abundance of fibrous roots; remember that trees from forests are transplanted with difficulty, and also those that have been grown in the shade.

Among the most desirable trees for the school-yard are the black cherry, willow-oak, red oak, tulip-tree, sugar-maple, red maple, linden, elm, ash, birch, beech, dogwood, pine, and horse-chestnut. The silver-maple, Carolina poplar, and box-elder will thrive where other trees will not grow.

Third, the planting. Prepare the ground before the time appointed for the placing of the tree. The excavation must be large enough to receive the roots without cramping them or forcing them into an unnatural position. The soil for the roots should be the same as that from which they have been removed, and dry enough to crumble readily—not wet or clammy, The roots should not become dry while being transferred from one place to the other. To prevent the wind blowing the tree, or any displacement of the roots, tie it firmly to a stake.

The planting is best done by two persons, the first to place the tree and hold it, the second to cover the roots with the earth. Then the tree must be watered, and every day a little attention bestowed upon it.

ARBOR DAYS IN THE UNITED STATES.

ALABAMA—February 22d.
*ARKANSAS—
*CALIFORNIA—
COLORADO—Third Friday in April.
CONNECTICUT—Late in April or early in May.
*DELAWARE—
FLORIDA—February 14th.
ILLINOIS—In the spring.
INDIANA—April and November.
IOWA—Late in April or early in May.
KANSAS—Early in spring.
KENTUCKY—March 31st.
*LOUISIANA—
*MAINE—
MARYLAND—In April.
MASSACHUSETTS--Last Saturday in April.
MICHIGAN—March 26th.
MINNESOTA—In April.
*MISSISSIPPI—
MISSOURI—First Friday after first Tuesday in April.
NEBRASKA—April 22d.
NEVADA—In April.
NEW JERSEY—Middle of April.
NEW YORK—Friday following the first day of May.
*NORTH CAROLINA—
OHIO—April 26th.
OREGON—February 25th.
PENNSYLVANIA—April and October.
RHODE ISLAND—In the spring.
*SOUTH CAROLINA—
TENNESSEE—In November.
TEXAS—Washington's Birthday.
VERMONT—In the spring.
*VIRGINIA—
WEST VIRGINIA—In November.
WISCONSIN—April 30th.

* No provision as yet by law or by the State Superintendent of Schools.

Special Exercises.

THE ARBOR DAY QUEEN.

By A. S. Webber.

Nine girls are needed, one of them as Queen. They enter the room singing "La, la, la" to the air "Here we go round the Barberry Bush." The Queen is preceded by two girls and followed by the remaining six in couples. A piece of white cheese cloth, several yards in length, is fastened to the shoulders of the Queen by the corners and carried by the six as a train. Any pretty form of march the room will allow may be given before the Queen stops in her proper place. Then the head couple separate, stepping from before her, and repeat—

We bring to-day our spring-time Queen,
  To grace our Arbor Day,
And now we'll bring the boughs we glean,
  And hear what she will say.

The head couple then lead a march in opposite directions, followed by the remaining six, who separate and follow their leader. Branches of trees should be so placed in the room that each can take one and not interrupt the march, which should end by coming in couples behind the Queen. The head couple step forward, not directly before the Queen, and make a low bow.

First girl lays her branch at the Queen's feet, saying :

I, a branch of oak now bring,
Among the trees 'tis called the king.

Second girl lays hers down, saying :

He may be king, but I can find
A tree more suited to my mind.
And now, dear Queen, this dogwood, see,
It is the prettiest far to me.

First girl :

But for this day, now don't you know,
It makes us think too much of snow.

Then the third and fourth girls step up, taking the hands of the first couple. All four bow to the Queen. The first couple then step back a few paces.

Third girl lays down her branch saying :

I bring the birch, so full of spice
That none can help but think it nice

Fourth girl :

But I prefer the stately grace
Of the tall elm to all the race.
To you, our Queen, I have brought now
From yonder elm a slender bough.

Third girl :

Your elm may many graces bring,
But with no birch can it be spring?

The next couple step up, joining hands, and bowing like the others. Then the second couple step back, joining hands with the first couple, while the other proceeds.

Fifth girl :

I've brought a willow, where, we know,
The softest little pussies grow.

Sixth girl :

But that a shrub, you know, they call,
Or else do not name it at all.
Now I have brought the maple fair,
A tree much loved everywhere.

Fifth girl :

But you'll find, to this world's end,
That every child's the willow's friend.

Last couple step up as the others.

Seventh girl :

A hickory I bring thee, Queen,
As fine a tree as I have seen,

Eighth girl :

And I this little branchlet took
From off the alder by the brook.
It made so sweet a picture there,
I could but think the tree was fair.

Seventh girl :

But we judge trees by what they do,
The good they bring to me and you.

They step back with the others, and the Queen says :

I'll think of all that you have said,
  And when next year we meet,
With branches you shall crown my head,
  Not lay them at my feet.

The two semicircles now join hands, moving around the Queen, singing to the same air :

Now we will sing to Arbor Day,
To Arbor, Arbor Day ;
Now we will sing to Arbor, Arbor Day,
While trees are just awaking.

And we will sing to forest trees,
To forest, forest, forest trees ;
And we will sing to forest trees,
That help our merrymaking.

And we'll sing to our spring-time Queen,
Our spring-time, spring-time, spring-time Queen ;
And we'll sing to our spring-time Queen,
Who'll soon her leave be taking.

They continue singing " La, la, la " to the air, and stop turning when the seventh and eighth girls are before the Queen, when the circle breaks, the seventh and eighth lead a march in opposite directions around the Queen, while she hands one of the branches to each girl as she passes before her. When all are given and the leaders meet before her, they continue the march by going in opposite directions from the Queen, place the branches from where they were first taken, and come behind the Queen in couples,

The leaders, seventh and eighth girls, come before the Queen, to be the couple to precede her. The Queen will at once follow, and the remaining six will carry the train.

THOUGHTS ABOUT TREES.

(To be given as quotations by the grammar grade. Music should be interspersed between the recitations, either instrumental or vocal.)

First pupil: We, representatives of the school-children of the United States, meet to-day to do our share toward making our country more beautiful and fertile. A treeless yard or street is unsightly and desolate, and how much more a whole city or district! Believing that the wholesale destruction of trees is an injury to our land, and wishing to make the place where we live more beautiful, we now replace those cut down by new, thrifty, and vigorous growths.

Second pupil:

Green and lovely ye shall stand,
O ye trees!
While the summer breeze
Sweeps your crests with its caressing hand.
Strong and stately ye shall rear
Your proud forms,
While the winter storms
Strip you of the leaves that were so dear.

Third pupil: Ah, the world has many forms of beauty to show in mountain, stream, and field, but nothing can so inspire and, at the same time, soothe me as the study of a beautiful tree. Indeed, I count all living trees beautiful, for nature never made an unsightly sweep of branch and limb, an unsymmetrical form, an unshapely leaf.

Fourth pupil: Think of the significance of a tree in the desert! The rider over the waste of sun-scorched sand looks eagerly ahead, and there is no sight so welcome to his strained gaze. It means shade and rest for

the tired body, water to quench the thirst, and, often, fruit to refresh the palate. This is its meaning to a traveller who has not fainted by the way. But think of the tremendous significance of the sight to one whose last drop of water is gone, who, almost overcome, still clings to the hope that an oasis is near. The green outline sharply defined against the sky is the mute answer, "Yes," to all his agonized questionings. It is the very boon of life to him.

Fifth pupil:

Upon a little knoll with grassy bosom
  Three trees stood out alone from all the rest,
Three stern old pines, whose sharp outlines were
    softened—
  By glowing colors painted in the west.

The softly splendid light shone boldly through them,
  Lighting their finger-tips with spires of flame;
Transfigured were they for a little season,
  Then, dull and gray, the twilight slowly came.

Sixth pupil (holding a branch of the willow tree): The willow is almost the earliest to gladden us with the promise and reality of beauty in its graceful and delicate foliage, and the last to scatter its yellow, yet scarcely withered, leaves upon the ground. All through the winter, too, its yellow twigs give it a gleaming aspect, which is not without a cheering influence, even in the grayest and gloomiest day. Beneath a clouded sky it faithfully remembers the sunshine.

Seventh pupil:

The grim old oaks
Are sentinels to watch for coming spring,
And stand with folded arms and fluttering leaves,
Scant remnants of the summer glory past.

Eighth pupil (displaying a branch of maple):

Green is its canopy in June,
In the branches birds are all in tune;
In the fall a cloak of red
Wraps it up to its proud tall head.

Take the birds with their songs so sweet,
Take the grass and the rustic seat;
Take them all, but leave to me,
This one sun-kissed maple tree.

CHORUS.—"Who will to the Greenwood Hie?"
—*J. L. Hatton.*

Ninth pupil:

O happy trees which we plant to-day,
What great good fortunes wait you!
For you will grow in sun and snow
Till fruit and flowers freight you.

Your winter covering of snow,
Will dazzle with its splendor,
Your summer's garb, with richest glow,
Will feast of beauty render.

In your cool shade will tired feet
Pause, weary, when 'tis summer,
And rest like this will be most sweet
To every tired new-comer.

So do your work, O graceful trees!
Ye have a share in giving;
If ye shall bless mankind like these, (*indicating neighboring trees.*)
Your life will be worth living.

SONG.—"Let's be Singing."—*Hauptman.*

Tenth pupil:

What gardeners like the trees! their loving care
The daintiest blooms can deftly plant and rear.
How smilingly with outstretched boughs they stand
To shade the flowers too fragile for man's hand!
With scented leaves, crisp, ripened, nay, not dead,
They tuck the wild-flowers in their moss-rimmed bed.
The forest nook outvies the touch of art,
The heart of man loves not like the oak's heart.

Eleventh pupil: What conqueror in any part of "life's broad field of battle" could desire a more beautiful, a more noble, or a more patriotic monument than a tree planted by the hands of pure and joyous children,

as a memorial of his achievements? What earnest, honest worker with hand and brain for the benefit of his fellow-men, could desire a more pleasing recognition of his usefulness than such a monument—a symbol of his or her productions, ever growing, ever blooming, and ever bearing wholesome fruit?

Twelfth pupil:

I love thee when thy swelling buds appear
  And one by one their tender leaves unfold,
As if they knew that warmer suns were near,
  Nor longer sought to hide from winter's cold;
And when with darker growth thy leaves are seen
  To veil from view the early robin's nest,
I love to lie beneath thy wooing screen,
  With limbs by summer's heat and toil oppressed.

Thirteenth pupil: As you drop the seed, as you plant the sapling, your left hand hardly knows what your right hand is doing. But Nature knows, and in due time the Power that sees and works in secret will reward you openly. You have been warned against hiding your talent in a napkin, but if your talent takes the form of a maple-key or an acorn, and your napkin is a shred of the apron that covers "the lap of the earth," you may hide it there, unblamed; and when you render in your last account you will find that your deposit has been drawing compound interest all the time.

Fourteenth pupil (showing a branch of the oak):

A little of thy steadfastness,
Rounded with leafy gracefulness,
    Old oak, give me—
That the world's blast may round me blow,
And I yield gently to and fro,
While my stout-hearted trunk below
And firm-set roots unshaken be.

LITTLE RUNAWAYS.

By Elizabeth R. Morey.

(This is for the primary children. The teacher must provide large letters for them to display. As they sing they all hold their letters to form the words Arbor Day.)

Child representing Nature :

I hear somebody coming,

(*Enter several children.*)

Now tell who are these?

Children : We little ones have come here
To see you plant the trees.

Nature : Whence come you?

Children : From the Alphabet,
Don't tell; we've run away.
We want to see how big folks
Keep their spring-time holiday

First child, A :

I am mamma's darling girlie,
That's what I've heard her say;
You want to know my name, I s'pose.
It's just this : big, big A.

Second child, R :

And I'm A's little brother.
Oh, we have come so far!

Nature : Have you a name?

Second child, R :

Of course I have :
My mamma calls me R.

Third child, B :

I am their little cousin ;
Perhaps you don't know me?
My mamma says I look like R,
But my name is only B.

Fourth child, O :

They call me "Roly-Poly,"
Because I'm round, you know;
If you want to know my truly name,
I'll tell you : it is O.

Fifth child, R:

I'm most afraid I've lost my way.
  Oh, dear! I want mamma!
What is my name? Why, don't you know?
  I'm just another R.

Sixth child, D:

I want to find my papa now
  And see him plant a tree.
Won't some one tell him I am here—
  His little daughter D?

Nature: Here comes another naughty child.
Come, little runaway,
And tell your name.

Seventh child, A:

Oh, don't you know?
I'm mamma's darling A.

Eighth child, Y:

I saw the others come this way,
  And that's the reason why
I'm here; if you would know my name,
  I'll tell you: it is Y.

Together: We hope no one will try to learn
  The Alphabet to day,
For, if they do, they'll surely find
  That we have run away.
Of course, to run away, we know,
  Is always very wrong;
But now we're here, maybe you'd like
  To have us sing a song.

Song. (*Tune:* "Comin' Thro' the Rye.")

Now the spring-time sun is shining
  On the fields, I ween;
Veiled in misty robes of greenness,
  All the trees are seen.
And we little lads and lassies
  Now have come this way,
So let us help you all to keep
  This happy Arbor Day.

Let us plant for future ages
  Now the spreading trees;
Birds shall build their nests within them,
  Rocked by ev'ry breeze.
Little children too shall bless us
  In the coming years,
And ev'ry face shall wear a smile
  When Arbor Day appears.

NOVEMBER'S PARTY.

Arranged as a Pantomimic Reading for the primary department by the author of "Preston Papers."

(The effectiveness of this exercise will depend upon the costumes and upon the thoroughness of the drill which must time the action to the word. The reader is secluded, and the pantomime keeps pace with the reading.)

November gave a party;
  The leaves by dozens came;
The Ashes, Oaks, and Maples, (1)
  And leaves of every name

The Chestnuts came in yellow;
  The Oaks in crimson drest;
The lovely Misses Maple
  In purple looked their best.

The sunshine spread a carpet,
  And everything was grand;
Miss Weather led the dancing, (2)
  Professor Wind the band. (3)

All balanced to their partners, (4)
  And gayly fluttered by.
The sight was like a rainbow
  New-fallen from the sky. (5)

Then in the rusty hollows
  At hide-and-seek they played; (6)
The party closed at sundown,
  And everybody stayed. (7)

Professor Wind played louder,
They flew along the ground.
And there the party ended
In jolly "hands all round." (8)
—*George Cooper.*

The scene opens with November in the centre of the stage receiving his guests, who come by twos and threes and single, being announced by pages at the door, left end of stage. Guests scattered in groups all about.

1. Enter Ashes, Oaks, and Maples.
2. Dancing sets are formed, with "Miss Weather" and partner at the head of the most prominent set.
3. Professor Wind and band play vigorously at right end of stage.
4. "Balance" all.
5. Finish any simple quadrille.
6. Separate as for a romp at hide-and-seek.
7. Come together as before for a "last measure."
8. "All hands round."

CHARACTERS AND COSTUMES.

November—a large boy; gorgeous costume, with white wig and whiskers.

Miss Weather—slender, with long hair, crimped, fluffy, and sparkling with diamond-dust. Dress of gauzy material, sombre in hue, with bright sash, gay stockings, and slippers.

Professor Wind—dressed to imitate a drum-major, as nearly as possible; must wear gloves, carry a baton, and assume a pomposity if he has it not.

The Band—six small boys, with cornets, drums, cymbals, etc., which may be made for the occasion or procured at a toy store—the real music being produced by piano (or organ) and violin concealed from sight; the band only making believe.

The colors for the guests are suggested by the poem—and for the girls may be made from cheese-

cloth or tissue-paper. Where no other color is mentioned, green in the various shades may be used.

The tinier the tots who can be drilled for the dancing, the better.

THE COMING OF SPRING.

By Annie Isabel Willis.

Scene I.—A Spring Greeting.

(Curtain rises, showing stage arranged to represent out-door scene. Floor should be green, with flowering plants in pots, placed to look as if growing out of the ground. At one side, partly screened by a hanging curtain, have large branches arranged to look like a tree, and place a toy bird among them. A boy, stationed out of sight, should imitate a bluebird's notes, or blow on one of the toy whistles made to sound like a bird's song. As the bird is singing, curtain rises, and a little girl comes in from opposite side of stage from where the bird is. She should be dressed as prettily as possible in a plush or fur-trimmed cloak and a hood, and speak as follows.)

Hark, ho! what do you sing about,
Bluebird a-swinging on brown branches bare
March winds the dead leaves so recklessly fling about,
Snow-drifts by fences lie white everywhere.
You're a promise of Spring,
You dear, brave little thing.
As you sway in the wind on the apple-tree bough;
And as bright is your note
As the blue of your coat—
Oh, say what you find, sir, to sing about now?

Stoops over as she walks about, and touches a yellow flower caressingly with her hand.

What ho! here is a daffodil—
Through wet mould just pushing its slender green head!
Daffy, dear daffy, say, now don't you think you will
Wish yourself back in your snug winter bed,
When night, cold and chill,
Settles over the hill,
And bonny, blithe bluebird no longer is heard?
Won't you shudder and weep
And catch cold in your sleep,
And wish your spring opening had long been deferred?

Heigh-ho! how March winds are blowing!
The ground is all sodden with late-fallen rain;
Yet I can but be happy when daffy is showing,
When sun shines so bright and bluebird sings again;
For I know the sweet spring
Will make haste as you sing,
My glad little minstrel so dauntless and true,
And when daffy seeks day,
Why, then winter *can't* stay,
And the spring-time brings promise to me and to you.

—*Mary Clark Huntington.*

Curtain falls.

Scene II.—The Baby Spring—March.

(Stage arranged as before. Young man with long cloak and cap, both dotted slightly with cotton to represent snow, enters. He holds in his arms baby in a long white cloak. Yellow curls should show below its white cap. Two attendants of March, Wind and Snow, follow, and all stand facing audience. New Year, with the Baby Spring in centre, Snow and Wind on either side. The former is dressed in pure white, and should be shod with white, so as to walk noiselessly. The latter has on a suit of gray, with long ribbon streamers of gray from hair and shoulders.)

New Year:

"Make way! make way!" cried the blithe young Year,
"For me and my bonny prize.
I have found her under a snow-drift deep,
Rosy and dimpled, and fast asleep,
With the dew of dreams in her eyes.

"I lifted the folds of her blanket white,
And her silken scarf of green;
She put out a wee white hand, and sighed,
And drowsily opened her blue eyes wide,
With the smile of a tiny queen.

"I caught her up from the frozen ground,
And, oh! but she fretted sore,
Till I kissed her a kiss on her dewy mouth,
As sweet as the breath of the blossoming south,
And she laughed in my face once more.

"Play low, rude wind, on your mighty harp;
Shine, sun, in the wintry skies;
Bloom, flowers, and weave her a garment sweet;
Be soft, cold earth, for her tender feet,
And fair for her pretty eyes!

"Make ready a jubilant welcoming
(She sleeps and wakes the while);
And happy he who may kiss her hand
As we go on our journey across the land,
Or catch from her lips a smile.

"Make way! make way!" cried the lordly Year
"For me and the prize I bring.
I found her under a snow-drift deep;
I caught her out of the arms of sleep,
The fair little stranger, Spring."

Wind:

The March wind bold blows fast and cold
When the Baby Spring comes in;
But he loves her well, for his hoarse notes swell,
And he sings her a cradle hymn.

Snow:

She is young and sweet, and her tender feet
Grow weary on the way,
Then March snows cover the tired child over,
And she rests in bed for a day.

Wind and Snow:

O, the child most dear of the bold new year
Is the dainty Baby Spring;
She is young and fair and she needs much care,
So we pledge her everything.
We will soothe her to sleep, and cover her deep
With blankets of purest white;
When she wakes again we will leave her train
To rain and sunshine bright.

Curtain falls.

Scene III.—The Girl Spring—April.

(Curtain rises, showing Spring, now a girl about twelve, dressed in pale green, with a few white and yellow flowers in her hair and around the hem of her dress. She is attended, as April, by Rain and Sunshine. Rain is in a dress of bluish-white tarleton, with a veil and a few spangles to represent raindrops. She holds some wet branches of green leaves in her hands. Sunshine is attired in yellow tarleton, with a yellow veil, and carries a golden wand.)

April:

April is here!
There's a song in the maple, thrilling and new;
There's a flash of wings of the heavens' own hue;
There's a veil of green on the nearer hills;
There's a burst of rapture in woodland rills;
There are stars in the meadow dropped here and there;
There's a breath of arbutus in the air;
There's a dash of rain as if flung in jest;
There's an arch of color spanning the west;—
April is here!

—*Emma C. Dowd.*

Rain:

The warm sweet rain is falling
From April's changeful skies;
The green leaves on the willows
Laugh out their glad surprise;
The violet wakes from dreaming
Beneath the dead year's leaves;
Each blossom adds its brightness
To webs that spring-time weaves.

The robin in the maple
Sings fitfully and low,
As if he'd half forgotten
The songs he used to know;
His little heart is happy
As from his burnished wing,
In pauses of his singing,
He shakes the rain of spring.

The buds on oak and elm-tree
Seem growing as we look;
Spring legends are repeated
By the babbling little brook.

The air is full of sweetness,
  The skies are brighter blue,
The rain that falls in April
  Makes all the old world new.
—*Eben E. Rexford.*

Sunshine :

The fitful April sunshine
  Is welcome after rain ;
She fills the earth with beauty,
  And lights it up again ;
Her golden wand uplifted
  Sends raindrops scattering far,
And flowers spring to greet her,
  Each shining like a star.

She makes the lowliest hovels
  Like palaces of gold,
Her hands are full of blessings,
  More full than they can hold :
There's not a person sees her
  But brighter grows his face,
There is no guest so cheery
  In every gloomy place.

Scene IV.—The Maiden Spring—May.

(Stage should be arranged with as many flowers and branches of leaves as possible. Enter the Maiden Spring, or May, dressed in white, with long veil covering head and dress. Both veil and dress should be dotted with natural flowers sewed here and there on them. The following flowers enter with May as her attendants, each dressed in white, with shoulder-sash of same color as the flower, and carrying real or imitation flowers of the kind represented : two Roses, two Lilies, two Violets, Pink, Daisy, Daffodil, and Arbutus. All form tableau at centre of stage, May in centre.)

May:

All the buds and bees are singing ;
All the lily bells are ringing ;
All the brooks run full of laughter,
And the wind comes whispering after.
What is this they sing and say ?
  "It is May !"

Look, dear children, look ! the meadows,
Where the sunshine chases shadows,

Are alive with fairy faces,
Peeping from their grassy places.
What is this the flowers say?
"It is May!"

See! the fair blue sky is brighter,
And our hearts with hope are lighter;
All the bells of joy are ringing;
All are grateful voices singing;
All the storms have passed away;
"It is May." —*Selected.*

Roses:

We are blushing roses,
Bending with our fulness,
'Midst our close-capped sister buds,
Warming the green coolness.

Hold one of us lightly—
See from what a slender
Stalk we bower in heavy blooms,
And roundness rich and tender.
—*Leigh Hunt.*

Lilies:

We are lilies fair,
The flower of virgin light:
Nature held us forth, and said,
"Lo! my thought of white."

Ever since then, angels
Hold us in their hands;
You may see them when they take
In pictures their sweet stands.

Like the garden's angels
Also do we seem;
And not the less for being crowned
With a golden dream. —*Leigh Hunt.*

Violets:

We are the sweet flowers
Born of sunny showers
(Think, whene'er you see us, what our beauty saith);
Utterance, mute and bright,
Of some unknown delight,

We fill the air with pleasure by our simple breath ;
All who see us love us—
We benefit all places ;
Unto sorrow we give smiles—and unto graces, races.
—*Leigh Hunt.*

Pink :

And dearer I, the pink, must be,
And me thou sure dost choose,
Or else the gard'ner ne'er for me
Such watchful care would use ;
A crowd of leaves enriching bloom !
And mine through life the sweet perfume,
And all the thousand hues. —*Goethe.*

Daisy :

The flower that's bright with the sun's own light,
And hearty and true and bold,
Is the daisy sweet that nods at your feet,
And sprinkles the field with gold.

Daffodil :

The dainty Lady Daffodil
Hath donned her amber gown,
And on her fair and sunny head
Sparkles her golden crown.

Her tall green leaves, like sentinels,
Surround my lady's throne,
And graciously, in happy state,
She reigns a queen alone.
—*Mary E. Sharpe.*

Arbutus :

If Spring has maids of honor—
And why should not the Spring,
With all her dainty service,
Have thought of some such thing ?

If Spring has maids of honor—
Arbutus leads the train ;
A lovelier, a fairer,
The Spring would seek in vain. —*H. H.*

(Piano at once strikes up a march, and all perform a fancy march about May. It would add to effect if they could sing while marching. Just as they form in tableau after march, have a colored light burned. Curtain falls.)

THROUGH THE YEAR WITH THE TREES.

By Olive E. Long.

(This exercise may be given either out of doors or from the platform of a school-room. If out of doors, the tree may be planted beforehand. The school, grouped as a chorus, opens with a song.)

Song: "All by the Shady Greenwood Tree."

(Words and music page 42 of "The Polytechnic," A. S. Barnes & Co.)

All by the shady greenwood tree
The merry, merry archers roam;
Jovial and bold and ever free
They tread their woodland home.
Roving beneath the moon's soft light,
Or in the thick, embowering shade,
Listening the tale, with dear delight,
Of a wandering sylvan maid.

(*At the close of the song a girl dressed in green and trimmed with leaves to represent the dryad of the tree, steps to the side of the tree.*)

Dryad: I am the spirit of the tree. Long ago men called us dryads. Nowadays men have almost forgotten that we exist, but every tree has its dryad that rejoices with the joy of living while the tree lives and dies when the tree dies. I come to greet you from my home far in the forest. Transported from that happy place of blue skies and soft mosses, I come as a country cousin to the busy world to find that the skies are blue here also, and hope that I may find new friends to replace the old familiar ones which I have left. When first I woke to consciousness it was to watch over this tree of mine, though perhaps you would not have known it for a tree then, wrapped up as it was in a little brown bundle that you call a seed. But the life came one glad spring morning, when the soft rain and the warm sun coaxed me from my little cradle up into the wide forest home. Did you ever know how the rain can call? Listen to it!

(*Turns to the chorus, one of whom steps forward and recites:*)

Rain and the Flowers.

To the great brown house where the flow'rets live
Came the rain with its tap, tap, tap!
And whispered: "Violet, Snowdrop, Rose,
Your pretty eyes must now unclose
From your long wintry nap!"
Said the rain with its tap, tap, tap!

From the doors they peeped with a timid grace,
Just to answer this tap, tap, tap!
Miss Snowdrop courtesied a sweet "Good-day!"
Then all came nodding their heads so gay,
And they said: "We've had our nap,
Thank you, Rain, for your tap, tap, tap!"
—*Selected.*

Dryad: And so it was no wonder that I dared venture forth, too, into the mystery of life. And what a home mine was,—a wide-reaching host of friends, all breathing a welcome to me, their new little neighbor, in the soft spring-time. I felt it was the spring, even though it was the first I had ever known, for everything was telling of it; the warm sunshine filtering down through the budding branches, the quiet dew, the rain, gentler and softer than ever, and the waking flowers, just answering the call of the wind.

(*A pupil steps forward and recites:*)

Pussy Willow.

The brook is brimmed with melting snow,
The maple sap is running,
And on the highest elm a crow
His black wings is sunning.
A close green bud the Mayflower lies
Upon its mossy pillow;
And sweet and low the south wind blows
And through the green field calling goes,

"Come, Pussy! Pussy Willow!
Within your close brown wrapper stir;
Come out and show your silver fur;
Come, Pussy! Pussy Willow!"

Soon red will bud the maple-trees,
And bluebirds will be singing,
And yellow tassels in the breeze
Be from the poplars swinging;
And rosy will the May-flower lie
Upon its mossy pillow;
But you must come the first of all,—
"Come, Pussy!" is the south wind's call,—
"Come, Pussy! Pussy Willow!"
A fairy gift to children dear,
The downy firstling of the year,—
Come, Pussy! Pussy Willow!

Dryad: And was it the wind, too, or which one of all my neighbors could have whispered to the poets of the spring that they could so tell of it?

(*A pupil steps forward and recites:*)

And at night so cloudless and so still! Not a voice of living thing,—not a whisper of leaf or waving bough,—not a breath of wind,—not a sound upon the earth or in the air! And overhead bends the blue sky, dewy and soft, and radiant with innumerable stars, like the inverted bell of some blue flower sprinkled with golden dust and breathing fragrance. Or, if the heavens are overcast, it is no wild storm of wind and rain, but clouds that melt and fall in showers. One does not wish to sleep, but lies awake to hear the pleasant sound of the dropping rain.

—*Longfellow.*

(*As the pupil steps back the chorus sings:*)

SONG: "Wandering in the May-time."

(Words and music on page 52 of Loomis' "Glee and Chorus Book," Ivison, Blakeman, Taylor & Co.)

Dryad: Besides, my silent friends, the sunshine, the dew, and the stars, there was the brook, gurgling over its bed and telling its own story as it went.

(*A pupil steps forwand and recites Tennyson's "Song of the Brook." She may be appropriately decorated with water-grasses and ferns.*)

Dryad: And the birds flooding the whole forest with their music, till the sleepiest flowers knew it was time for them to awake! Many were the spring-times that I saw in the forest, but none of them were complete till the birds came.

A week ago the sparrow was divine;
The bluebird, shifting his light load of song
From post to post along the cheerless fence,
Was a rhymer ere the poet came;
But now, O rapture! sunshine winged and voiced,
Pipe blown through by the warm wild breath of the West,
Shepherding his soft droves of fleecy cloud;
Gladness of woods, skies, waters, all in one,
The bobolink has come, and, like the soul
Of the sweet season vocal in a bird,
Gurgles in ecstasy we know not what
Save *June! Dear June! Now God be praised for June.*
—*Lowell.*

(*As the Dryad ceases, the chorus sings the Bluebird Song:*)

(Words and music to be found on page 434 of the "Arbor Day Manual," Weed, Parsons & Co.)

PRETTY LITTLE BLUEBIRD.

Pretty little bluebird, singing in the trees,
Tell me, tell me if you please,
How you keep your dress so tidy and so new;
Tell me, tell me, little bird of blue.

Dryad: And I must not forget to speak of my nearest kinsman, the forest trees under whose protection I grew year by year. My other friends were careless playmates, but these gave me the careful advice of older brothers and sisters. One gnarled old oak in particular, who had lived through nearly a century of wintry storms, would send down his leaves in the spring to tell me of the importance and responsibility

of our brotherhood at this season of the year; how we moderated the temperature for the young and sensitive crops, and kept them from sudden changes; even man himself thanked us, when he understood enough to do so, for our effect in modifying the climate. Perhaps I don't listen as well as I should, for the south wind was telling me at the same time that a May-party was coming to the forest, and how could I help but be a tiptoe to see it?

(*Music,—some polka tune,—during which a group of May girls and boys dance in. They join hands and dance in a ring till the music changes to "Lightly Row," when they sing the first stanza of "May-song." Between the stanzas they break into the dance again, to the polka music.*)

MAY-SONG. (*Tune:* "Lightly Row.")

May flowers sweet, at our feet,
Raise their heads the spring to greet;
Violets, too, peeping through,
Fleck the hills with blue.
In the silent woods are heard
Hum of bee and song of bird;
Spring is here, spring is here,
Joy-time of the year.

(*One of the girls is placed in the centre of the ring and crowned with flowers.*)

Sunlight sheen crowns our queen,
Fairest ever yet was seen;
All the bowers scatter flowers
For this queen of ours.

(*Bow and scatter flowers at her feet.*)

To her feet we tribute bring
From the treasures of the spring;
Spring is here, spring is here,
Joy-time of the year.

(*They dance out to the polka music, leaving behind one little girl with a basket of flowers, who advances and recites:*)

Our Garden.

The winter is gone, and at first Jack and I were sad,
Because of the snow-man's melting, but now we are glad;
For the spring has come, and it's warm, and we're allowed to garden in the afternoon;
And summer is coming, and oh, how lovely our flowers will be in June!

We are so fond of flowers, it makes us quite happy to think
Of our beds—all colors—blue, white, yellow, purple, and pink,
Scarlet, lilac, and crimson! And we're fond of sweet scent as well,
And mean to have pinks, roses, sweet peas, mignonette, clove carnations, and everything good to smell.

On Monday we went to the wood and got primrose plants and a sucker of dog-rose;
It looks like a green stick in the midst of the bed at present, but wait till it blows!
The primroses were in full flower, and the rose ought to flower soon;
You've no idea how lovely it is in that wood in June!

The primroses look quite withered now, I am sorry to say;
But that's not our fault, but nurse's, and it shows how hard it is to garden when you can't have your own way.
We planted them carefully and were just going to water them all in a lump,
When nurse fetched us both indoors, and put us to bed for wetting our pinafores at the pump.

We're going to take everything up,—for it can't hurt the plants to stand on the grass for a minute.
And you really can't make a bed smooth with so many things in it.

We shall dig it all over, and get leaf-mould from the wood, and hoe up the weeds;
And when it's tidy we shall plant and put labels and strike cuttings and sow seeds.

We are so fond of flowers! Jack and I often dream at night
Of getting up and finding our garden ablaze with all colors,—blue, red, yellow, and white;
And midsummer's coming, and our big brother Tom will sit under the tree
With his book, and Mary will beg sweet nosegays of me.

It's so tiresome! Jack wants to build a greenhouse now.
He has found some bits of broken glass and an old window-frame, and he says he knows how.
I tell him there's not glass enough, but he says there's lots.
And he's taken all the plants that belong to the bed and put them into pots.

Juliana Horatio Ewing.

Dryad: But each year, as I laid aside my winter cloak and shook out my green robes, I grew a little taller, till in four or five summers I looked far down to see the little white violets at my foot, and was on nodding terms with the tallest bushes in the wood. Then the old oak did not need to send down its leaves as messengers, but could bend its lowest branches to tell me that now, since the summer-time had come, I must send my roots bravely down into the earth to cleave a path for the rain-drops, so that when they came rushing down they might fill the underground basins which keep alive the clear, cool springs all through the dry summer. And it told me that the rain loved us so well that it always came oftener to the countries where there were trees, and that if men only knew it they would never cut us down without planting others in our places.

And then it whispered to hang out my green

leaves,—as many as I could,—for they were little mouths that breathed out the oxygen that man and animals needed, and breathed in what they could not use. And then all the flowers nodded and smiled (because they were listening), and said they could do that, too. And the wind carried away our whisperings to freshen the breeze that was floating out into the plain.

And every day new flowers kept coming,—our quiet forest was growing into a ball-room of bright colors that danced with the wind to the music of the birds and the insects.

A Dream of Summer.

West wind and sunshine, braided together,
What is the one sign but pleasant weather?
Birds in the cherry-trees, bees in the clover,
Who half so gay as these, all the world over?

Violets among the grass, roses regretting
How soon the summer'll pass, next year forgetting!
Birds sighing in their sleep, "Summer, pray grant us
Youth, that its bloom will keep fragrance to haunt us."

Rivulets that shine and sing, sunbeams abetting,
No more remembering their frozen fretting;
Sweet music in the wind, sun in the showers;
All these we're sure to find in summer hours.

Dryad: How the flowers bloomed along the sides of the forest paths—the columbine, the asters, the clematis, and goldenrod!

(*A little girl in Kate Greenaway costume steps forward and recites:*)

O pretty Lady Goldenrod,
  I'm glad you've come to town!
I saw you standing by the gate,
  All in your yellow gown.
No one was with me, and I thought
  You might be lonely, too;
And so I took my card-case
  And came to visit you.

You're fond of company, I know ;
  You smile so at the sun,
And when the winds go romping past
  You bow to every one.
How you should ever know them all,
  I'm sure I cannot tell ;
And when I come again, I hope
  You'll know me just as well.

—*C. W. Bronson.*

Dryad : This was when the summer was going and the evenings were beginning to grow cooler, and the dandelion's crown was growing white.

SONG : " The Dandelion " (*with appropriate gestures*).
(Words and music found on page 181 of Tufts' and Holt's Second Music Reader.)

Little Dandelion spent
    All her days in sweet content
When she dressed in yellow ;
    So, too, did the sun on high,
   And the roving butterfly,
That most jolly fellow.

Dryad : And when the fall had come in earnest, we all put on our gayest colors to match the golden moon that gleamed at us in the soft nights.

(*Pupil recites :*)

FALL FASHIONS.

The maple owned that she was tired of always wearing green,
She knew that she had grown, of late, too shabby to be seen !
The oak and beech and chestnut then deplored their shabbiness,
And all, except the hemlock sad, were wild to change their dress.
" For fashion-plates we'll take the flowers," the rustling maple said,
" And like the tulip I'll be clothed in splendid gold and red ! "

"The cheerful sunflower suits me best," the lightsome beech replied;
"The marigold my choice shall be," the chestnut spoke with pride.
The sturdy oak took time to think: "I hate such glaring hues;
The gillyflower, so dark and rich, I for my model choose."
So every tree in all the grove, except the hemlock sad,
According to its wish ere long in brilliant dress was clad.
And there they stand through all the soft and bright October days;
They wished to be like flowers—indeed they look like huge bouquets. —*Selected.*

Dryad: And then the wood-paths grew gay with the chatter of children's voices, as they came with baskets and long poles, on their fruit-gathering and nutting parties. And somehow we all felt, as each golden autumn came round, that one of the great things we had lived for had come to pass, and the nut-trees freely scattered their brown treasures on the dry moss, and the wild plums and cherries blushed with pleasure at the visits of the birds and children.

HARVEST SONG BY THE CHORUS. (*Tune:* "Ward.")

Once more the liberal year laughs out
O'er richer stores than gems or gold;
Once more with harvest song and shout
Is nature's bloodless triumph told.

Our common mother rests and sings,
Like Ruth, among her garnered sheaves;
Her lap is full of goodly things,
Her brow is bright with autumn leaves.

O favors every year made new!
O gifts with rain and sunshine sent!
The bounty overruns our due,
The fulness shames our discontent.

We shut our eyes, the flowers bloom on;
  We murmur, but the corn-ears fill;
We choose the shadow, but the sun
  That casts it shines behind us still.

God gives us with our rugged soil
  The power to make it Eden-fair,
And richer fruits to crown our toil
  Than summer-wedded islands bear.
—*Whittier.*

Dryad: And then a day came when we knew it was time to send down our leaves on the wind. At first I hated to have them go and be left so bare, but every year it grew pleasanter, for the old oak would nod its head, and tell me how they helped to form a cover over the shivering earth, and kept it from freezing so deeply when the winter came. And it even went so far as to tell of the next year, and of how the forest would be covered with the light leaf-mould which the flowers and ferns all loved. And so each autumn, as I grew taller and waved my branches farther over the earth, I was glad that I had more of these bright leaves to scatter at my feet.

(*A pupil steps forward and recites:*)

HOW THE LEAVES CAME DOWN.

"I'll tell you how the leaves came down."
  The great tree to his children said,
"You're getting sleepy, Yellow and Brown,
  Yes, very sleepy, little Red."

"Ah!" begged each silly pouting leaf,
  "Let us a little longer stay;
Dear Father Tree, behold our grief;
  'Tis such a very pleasant day
We do not want to go away."

So, just for one more merry day
  To the great tree the leaflets clung,
Frolicked and danced, and had their way,
  Upon the autumn breezes swung,
  Whispering all their sports among,—

"Perhaps the great tree will forget,
And let us stay until the spring,
If we all beg, and coax, and fret."
But the great tree did no such thing;
He smiled to hear their whispering.

"Come, children, all to bed," he cried;
And ere the leaves could urge their prayer,
He shook his head, and far and wide,
Fluttering and rustling everywhere,
Down sped the leaflets through the air.

I saw them; on the ground they lay,
Golden and red, a huddled swarm,
Waiting till one from far away,
White bedclothes heaped upon her arm,
Should come to wrap them safe and warm.

The great bare tree looked down and smiled;
"Good-night, dear little leaves," he said.
And from below eaeh sleepy child
Replied, "Good-night," and murmured,
"It is so nice to go to bed!"

—*Susan Coolidge.*

Dryad: And then one day the snow came to put us all asleep, and spread a cloak of ermine over the coverlet of leaves.

Out of the bosom of the air,
Out of the cloud-folds of her garments shaken,
Over the woodlands brown and bare,
Over the harvest-fields forsaken,
Silent, and soft, and slow
Descends the snow. —*Longfellow.*

(*Song by group of primary children, with appropriate motions. Tune: "Lightly Row."*)

Lovely white, from the height
Falls the snow in flakes so white;
Spreads around, on the ground,
Mirth rings far and wide.
Let us now a snow-ball make,
At each other aim to take;
Oh what fun! do not run;
Never will it hurt.

Dryad: And yet the forest was not all asleep—the evergreens were glowing in their holiday attire—and rustled their snow-laden boughs as they talked of the joys of the coming Christmas-time. And the old oak, between its naps, sleepily told of our great usefulness in the coming spring,—and how we served the snow as well as the snow served us,—for when the warm sun would melt the flakes till they turned into trickling rills, and these into raging floods, we would keep away his burning glances till they slowly melted and sunk into the thirsty earth only as fast as she needed them. And when the freshets did come from the sudden melting on some barren hill-side, our roots held together the light soil and kept it from washing down to the swollen rivers below.

And by this time I listened more carefully to the oak's sage counsel, for I had learned that it always proved true. And so it was in this case, for when the spring came again to carry away the white cloak from the earth, it came gently and softly in our forest, while the wind brought to us tidings of great loss and pain, where, in the open country, its advent had been too sudden.

And it was because of our usefulness, as well as our beauty, that people began to visit our forest, to carry some of us away to other places where our help was needed. This is what we are, we trees, helpers of mankind as well as beautifiers of nature. And all the care you give us will be repaid a hundredfold by the added health and wealth and beauty that we bring to your country.

(*The chorus advances and closes in around the tree and Dryad as it sings the following song, written by D'Orfey about* 1680.)

(Music found on page 99 of Loomis' "Glee and Chorus Book.")

"IN SUMMER-TIME."

In summer-time, when flowers do spring,
  And birds sit on each tree,
Let lords and knights say what they will,
  There's none so merry as we.

There's Tom with Nell who bears the bell,
And Willy with pretty Betty ;
Oh, how we skip it, caper and trip it,
Under the greenwood tree !

Our music is a little pipe
That can so sweetly play.
We hire old Hal from Whitsuntide
Till latter Lammas-day.
When the day is spent, with one consent
Again we all agree
To caper and skip it, trample and trip it,
Under the greenwood tree !

MAY.

By Lettie Sterling.

(This may be given in the Northern States as an Arbor Day exercise. Five little girls, each holding a dandelion blossom and a seed-ball, should recite these verses and join in the song. At the close of the song, they may, with one puff of the breath, blow the seeds into the air. A light skip and a gesture toward the ceiling as they do this would add much to the effect.)

First girl :

Dandelions gay
Brighten meadows green ;
Little folks at play
Everywhere are seen.
Children love the dandelions,
Plucking them is joy.
"What a pretty flower ! "
Think the girl and boy.

Second girl :

Buttercups begin
Yellow heads to show ·
Shrubs and bushes in
Field and dooryard blow ;
Apple, pear, and cherry trees
Speak of storms of snow,
Thus they make the promise
That their fruit will grow.

Third girl:

Now and then we see
  Butterflies alight;
Now and then a bee
  Flies within our sight.
Birds and bugs are happy now;
  Cattle seem content,
And the hen's queer singing
  For a psalm is meant.

Fourth girl:

Rambling in the woods
  Has become the style.
There May's pretty goods
  Cause a grateful smile.
Gardens all begin to yield
  That which pleases taste;
At a hint of daylight,
  Workmen fieldward haste.

Fifth girl:

May is gentle, kind,
  Blithesome, cheering, bright;
Scarce a glance will find
  That she brings delight.
She would make the care and gloom
  From our hearts to flee;
We should all be trying
  Like this month to be.

(All sing together to the tune of "Jingle Bells.")

Little flakes of down
On the breezes sail,
Floating o'er the hill,
Rising from the dale;
Easily they move
With a gentle grace,
Trusting only winds to show
Their course and stopping-place.

CHORUS.—Flower-wings, flower-wings,
Floating through the air,
Safely bear the precious seeds
And plant them all with care.—[*Repeat.*]

In each speck of down
From its neighbors torn
Seeds of blossoms sweet
Far away are borne.
Where the down alights,
There the seeds will lie,
Springing up to grow and bloom
When winter hath gone by.

From the glade and glen,
From the dell and mead,
Come the dainty wings
With the loads of seed.
To the north and south,
To the east and west,
Still they journey, journey on,
Till all the earth is blest.

THE POETRY OF SPRING.

(The school-room or hall should be decorated and made to look as springlike as possible, and those taking part should be dressed in light colors and should all wear flowers. Appropriate songs should be sung at intervals throughout the exercise, and, if possible, a pretty dance may accompany one of them.)

RECITATION—"*Spring.*"

(By a little boy.)

The alder, by the river,
  Shakes out her powdery curls :
The willow buds in silver
  For little boys and girls.

The little birds fly over—
  And oh, how sweet they sing !—
To tell the happy children
  That once again 'tis spring.

And buttercups are coming,
  And scarlet columbine.
And in the sunny meadows
  The dandelions shine,

And just as many daisies
  As their soft hands can hold,
The little ones may gather,
  All fair in white and gold.

Here blows the warm, red clover,
  There peeps the violet blue;
O happy little children,
  God made them all for you!
—*Celia Thaxter.*

RECITATION—"*The Spring Months.*"

(By a boy.)

March! march! march! They are coming
  In troops to the tune of the wind—
Red-headed woodpeckers, drumming;
  Gold-crested thrushes behind;
Sparrows in brown jackets, hopping
  Past every gateway and door;
Finches with crimson caps, stopping
  Just where they stopped years before.

March! march! march! They are slipping
  Into their places at last—
Little white lily-buds, dripping
  Under the showers that fall fast;
Buttercups, violets, roses,
  Snowdrop, and bluebell, and pink;
Throng upon throng of sweet posies
  Bending the dewdrop to drink.

March! march! march! They will hurry
  Forth at the wild bugle-sound—
Blossoms and birds in a flurry,
  Fluttering all over the ground.
Hang out your flags, birch and willow!
  Shake out your red tassels, larch!
Grassblades, up from your earth-pillow!
  Hear who is calling—March!

RECITATION—"*April.*"

(By a girl.)

Robins call robins in tops of trees ;
  Doves follow doves with scarlet feet ;
Frolicking babies, sweeter than these,
  Crowd green corners where highways meet.

Violets stir and arbutus wakes,
  Claytonia's rosy bells unfold ;
Dandelion through the meadow makes
  A royal road with seals of gold.

Golden, and snowy, and red the flowers,
  Golden, and snowy, and red in vain ;
Robins call robins through sad showers,
  The white dove's feet are wet with rain.

For April sobs while these are so glad,
  April weeps while these are so gay,
Weeps like a tired child who had,
  Playing with flowers, lost its way. —*H. H.*

RECITATION—"*Princess May.*"

(By a girl.)

March and April go your way !
You have had your fitful day ;
Wind, and shower, and snow, and sleet,
Make wet walking for my feet.

For I come unsandalled down
From the hillsides bare and brown ;
But wherever I do tread,
There I leave a little thread

Of bright emerald, softly set
Like a jewel in the wet ;
And I make the peach-buds turn
Pink and white, until they burn
Rosy red within their cells ;
Then I set the blooming bells
Of the flowery alder ringing,
And the apple-blossoms swinging

In a shower of rosy snow,
As I come and as I go
On my gay and jocund way—
I, the merry Princess May. —*Nora Perry.*

MUSIC.

RECITATION—"*To The Cuckoo.*"

(By a boy.)

Hail, beautous stranger of the grove
 Thou messenger of spring!
Now heaven repairs thy rural seat,
 And woods thy welcome sing.

Soon as the daisy decks the green,
 Thy certain voice we hear;
Hast thou a star to guide thy path
 Or mark the rolling year?

Delightful visitant! with thee
 I hail the time of flowers,
And hear the sound of music sweet
 From birds among the bowers.
—*John Logan.*

RECITATION—"*The Swallow.*"

(By a boy.)

The gorse is yellow on the heath,
 The banks with speedwell flowers are gay,
The oaks are budding, and beneath
The hawthorn soon will bear the wreath,
 The silver wreath of May.

The welcome guest of settled spring,
 The swallow, too, is come at last;
Just at sunset, when thrushes sing,
I saw her dash with rapid wing,
 And hailed her as she passed.
—*Charlotte Smith.*

RECITATION—"*The Robin.*"

(By a girl.)

Of all the merry little birds that live up in the tree,
And carol from the sycamore and chestnut,
The prettiest little gentleman, that dearest is to me,
Is the one in coat of brown and scarlet waistcoat.
It's cockit little robin,
And his head he keeps a-bobbin',
Of all the other pretty birds I'd choose him ·
For he sings so sweetly still,
Through his tiny slender bill,
With a little patch of red upon his bosom.

—*Irish Legend.*

RECITATION—"*Apple Blossoms.*"

(By a girl who holds a branch of the flowers.)

The apple trees with bloom are all aglow ;
Soft drifts of perfumed light ;
A miracle of mingled fire and snow,
A laugh of spring's delight.

Their ranks of creamy splendor pillow deep
The valley's pure repose ;
On mossy walls, in meadow nooks, they heap
Surges of frosted rose.

Around old homesteads, clustering thick, they shed
Their sweets to murmuring bees.
And o'er hushed lanes and wayside fountains spread
Their pictured canopies.

—*Horatio Nelson Powers.*

RECITATION—"*The Daisy.*"

(By a little girl.)

Wake up, little daisy, the summer is nigh,
The dear little robin is up in the sky ;
The snowdrops and crocus were never so slow :
Then wake, little daisy, and hasten to grow.

I tease pleasant sunshine to rest on your head,
The dew and the raindrops to moisten your bed;
And then every morning I just take a peep,
To see your wee face, but you're still fast asleep.

Now hark, little daisy, I'll tell you what's said :
The lark thinks you're lazy and love your warm bed.
But I'll not believe it, for now I can see
Your bright little eye winking softly at me.

RECITATION—"*Violets.*"

(By a girl who shows a pot of violets.)

Under the green hedges after the snow,
There do the dear little violets grow,
Hiding their modest and beautiful heads
Under the hawthorn, in soft mossy beds.

Sweet as the roses, and blue as the sky,
There do the dear little violets lie,
Hiding their heads where they scarce may be seen.
By the leaves you may know where the violet hath
been.

—*J. Moultrie.*

RECITATION—"*Hepatica.*"

(By a girl.)

Ere snows have left the woodland ways,
On sunny morns of April days
I find thee smiling, as in glee,
And peeping through the leaves at me.

The alder-bushes barely show
Their golden tassels o'er the snow,
And pussy-willow's silky cap
Proclaims her yet unbroken nap.

But thou, bright flower, brimful of mirth,
Art here to welcome April's birth,
A sign to us that not in vain
Has been the winter's snow and rain.

—*W. W. Bailey.*

RECITATION—"*May Flowers.*"

(By a girl.)

If you catch a breath of sweetness,
And follow the odorous hint
Through woods where the dead leaves rustle
And the golden mosses glint,

Along the spicy sea-coast,
  Over the desolate down,
You will find the dainty May-flowers,
  When you come to Plymouth town.

Where the shy spring tends her darlings,
  And hides them away from sight,
  Pull off the covering leaf-sprays
  And gather them, pink and white.

Tinted by mystic moonlight,
  Freshened by frosty dew,
Till the fair transparent blossoms
  To their pure perfection grew.

—*Louise Chandler Moulton.*

MUSIC.

RECITATION—"*In Spring-time.*"

(By a boy.)

Down the peach-tree slid
  The milk-white drops of th' dew,
All in that merry time of th' year
  When the world was made anew.

The daisy dressed in white,
  The pawpaw flower in brown,
And the violet sat by her lover, the brook,
  With her golden eyelids down.

Gayly its own best hue
  Shone in each leaf and stem,
Gayly the children rolled on th' grass
  With their shadows after them.

—*Alice Carey.*

RECITATION—"*In Blossom-time.*"

(By a girl.)

Its oh, my heart, my heart,
  To be out in the sun and sing!
To sing and shout in the fields about,
  In the balm and the blossoming.

Sing loud, O bird in the tree;
  O bird, sing loud in the sky;
And honey-bees, blacken the clover seas:
  There are none of you glad as I!

The leaves laugh low in the wind,
Laugh low with the leaves at play ;
And the odorous call of the flowers all
Entices my soul away !
—*Ina D. Coolbrith.*

RECITATION—" *May Morn Song.*"

(By a boy who imitates the lark's song in the thirteenth line.)

The grass is wet with shining dews,
Their silver bells hang on each tree,
While opening flower and bursting bud
Breathe incense forth unceasingly.
The mavis pipes in greenwood shaw,
The throstle glads the spreading thorn,
And cheerily the blithesome lark
Salutes the rosy face of morn.
'Tis early prime ;
And hark ! hark ! hark !
His merry chime
Chirrups the lark :
Chirrup ! chirrup ! he heralds in
The jolly sun with matin hymn.
—*William Motherwell.*

THE PLEA OF THE TREES.

(This is to be spoken by nine boys. The woodman is dressed in an old brown suit ; a felt hat is pushed back on his head, and an axe is held in his hand. The other boys carry each a branch of the tree he represents.)

The Woodman :

" And now in the forest the woodman doth stand,
His eye marks the victims to fall by his hand."
And all the trees shiver and tremble for fear.
Hark ! they plead for their lives ! will the woodcutter
hear ? —*Adapted.*

The Oak :

I am a monarch, the king of the trees ;
Calmly I rise, and spread by slow degrees ;
Three centuries I grow ; and three I stay
Supreme in state ; and in three more decay.
—*Dryden.*

(Suggestions: Their use in building our homes, ships, and vehicles; the immense value of the forests of the United States, worth $700,000,000 every year; trees are also useful in preventing miasma and in inducing rainfall. These subjects may be treated in three separate essays, if preferred.)

So the deacon inquired of the village folk
Where he could find the strongest oak,
That couldn't be split, nor bent, nor broke—
That was for spokes, and floors, and sills.
He sent for lancewood to make the thills;
The cross-bars were ash, from the straightest trees;
The panels of white-wood, that cuts like cheese,
But lasts like iron for things like these;
The hubs from logs from the "settler's ellum"—
Last of its timber—they couldn't sell 'em—
Never an axe had seen their chips,
And the wedges flew from between their lips,
Their blunt ends frizzled like celery-tips;
* * * * *

That was the way he put her through.
"There!" said the Deacon, "naow she'll dew!"

—*O. W. Holmes.*

Covering many a rood of ground,
Lay the timber piled around;
Timber of chestnut, and elm, and oak,
And scattered here and there with these,
The knarred and crooked cedar knees;
Brought from regions far away,
From Pascagoula's sunny bay,
And the banks of the roaring Roanoke!
Ah! what a wondrous thing it is
To note how many wheels of toil
One thought, one word can set in motion!
There's not a ship that sails the ocean,
But every climate, every soil,
Must bring its tribute, great or small,
And help to build the wooden wall.

—*Longfellow.*

ESSAY—"*Some Historic Trees.*"

(Suggestions: The Charter Oak at Hartford, Conn.; The Washington Elm at Cambridge, Mass.; the Liberty Elm at Boston; the Burgoyne Elm at Albany, etc.)

Building the Birch Canoe.

4 *First pupil:*

" Give me of your bark, O birch-tree!
Of your yellow bark, O birch-tree!
Growing by the rushing river,
Tall and stately in the valley!
I a light canoe will build me,
Build a swift Cheemaun for sailing,
Thou shalt float upon the river,
Like a yellow leaf in autumn,
Like a yellow water-lily!"

* * * *

5 *Second pupil:*

And the tree with all its branches
Rustled in the breeze of morning,
Saying with a sigh of patience,
" Take my cloak O Hiawatha!"

* * * * *

6 *Third pupil:*

" Give me thy boughs, O cedar!
Of your strong and pliant branches,
My canoe to make more steady,
Make more strong and firm beneath me!"
Through the summit of the cedar
Went a sound, a cry of horror,
Went a murmur of resistance,
But it whispered, bending downward,
" Take my boughs, O Hiawatha!"
Down he hewed the boughs of cedar,
Shaped them straightway to a framework,
Like two bows he formed and shaped them,
Like two bended bows together.

Fourth pupil :

“ Give me of your roots, O tamarack !
Of your fibrous roots, O larch-tree !
My canoe to bind together
That the water may not enter,
That the river may not wet me !”

Fifth pupil :

And the larch, with all its fibres,
Shivered in the air of morning,
Touched his forehead with its tassels,
Said, with one long sigh of sorrow,
“ Take them all, O Hiawatha ! ”

Sixth pupil :

“ Give me of your balm, O fir-tree !
Of your balsam and your resin,
So to close the seams together
That the water may not enter,
That the river may not wet me.”

Seventh pupil :

And the fir tree, tall and sombre,
Sobbed through all its robes of darkness,
Rattled like a shore with pebbles,
Answered wailing, answered weeping,
“ Take my balm, O Hiawatha ! ”

All: Thus the birch canoe was builded
In the valley, by the river,
In the bosom of the forest ;
And the forest's life was in it,
All its mystery and magic,
All the lightness of the birch-tree,
All the toughness of the cedar,
All the larch's supple sinewes ;
And it floated on the river,
Like a yellow leaf in autumn,
Like a yellow water-lily. —*Longfellow.*

PART II.—AT THE TREE-PLANTING.

Teacher: Since we have been thinking about Arbor day some of you have been studying up the best method of tree-planting. Henry, will you tell us how you prepared the hole for the tree?

"The hole was made before the tree was brought here, which was the proper way. You see that the hole was made somewhat deeper and larger than seems necessary, so that the rains may penetrate the soil and the little rootlets have a chance to grow. We took the top soil, which is richer than the soil below, and placed it on one side. This should be placed in the bottom in filling the hole. We were careful to keep all stones out, though these may be used above the roots or on the surface."

Teacher: What is the proper way to plant this tree, James?

"It is best done by three persons, one to hold the tree, and two others to spade the earth under his direction. Great care should be taken that the tree is not set in too deep. While the director holds the tree perfectly straight, with the side bearing the fullest branches toward the south or south-west, the assistants spread out the roots with care. Then small spadefuls of earth should be carefully thrown over the roots, while the director slightly shakes the trunk, causing the earth to settle. After the soil is packed so as to keep the tree in place the earth should be trodden down firmly."

Teacher: Theodore, what can you tell us about watering and after-care of the tree?

"It is not a good plan to water the tree while planting, unless the water is carefully applied with a 'rose' after the soil is well filled in and packed around the fibrous roots. During the hot season the trees should be watered in the late afternoon or in the evening. Waste material—hay, straw, chips, sawdust, etc.—if placed around the roots is of excellent service in checking evaporation. The ground

should be kept free from weeds, and it should be occasionally hoed or raked. A tree-box will keep the tree safe from accidents."

WHITTIER EXERCISE.

1. Sketch of the poet's life.
2. Gems from Whittier.
   (These should be selected by the children.)
3. *Singing:* "Tribute to Whittier."
   (Page 31, "Song Treasures." Published by E. L. Kellogg & Co.)
4. *Recitation:* "Jack-in-the-Pulpit."
   (Any other suitable selection may be used.)

TREE-PLANTING SONG.

BY EMMA S. THOMAS.

[*Tune:* "America."]

Grow thou, and flourish well,
Ever the story tell,
Of this glad day;
Long may thy branches raise
To heaven our grateful praise,
Waft them on sunlight rays
To God away.

Deep in the earth to-day,
Safely their roots we lay,
Tree of our love.
Grow thou, and flourish long;
Ever our grateful song
Shall its glad notes prolong
To God above.

"Let music swell the breeze,
And ring from all the trees,"
On this glad day;
Bless Thou each student band
O'er all our happy land;
Teach them Thy love's command,
Great God, we pray.

Concert Recitation.

He who plants a tree
Plants a hope.
Rootlets up through fibres ~~blindly~~ grope;
Leaves unfold into horizons free.
So man's life must climb
From the sods of time,
Unto heavens sublime.
Canst thou prophesy, thou little tree,
What the glory of thy boughs shall be.

He who plants a tree,
He plants love;
Tents of coolness spreading out above
Wayfarers, he may not live to see.
Gifts that grow are best,
Hands that bless are blest.
Plant! Life does the rest.
Heaven and earth help him who plants a tree,
And his work its own reward shall be.

—*Lucy Larcom.*

(*Dismission.*)

Fancy Drill.

THE PINK ROSE DRILL.

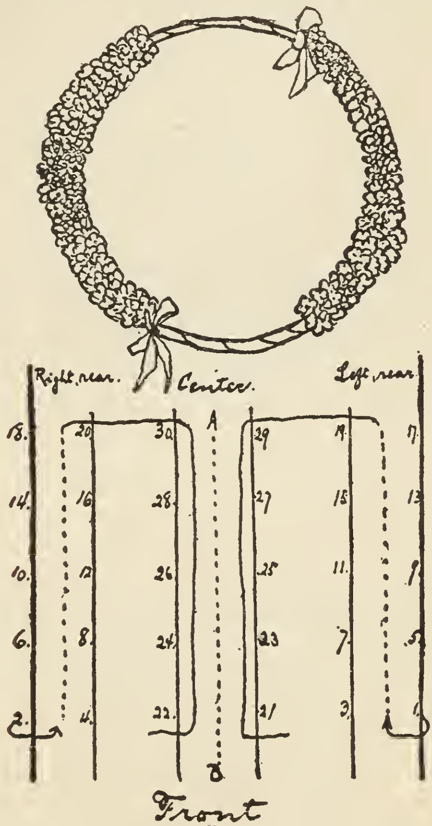
By Eloise Hemphill.

(The dresses should be of some *soft* white material, trimmed elaborately with pink roses and ribbon. Each pupil should have a wreath of roses, which she holds in her *right* hand when marching. The wreath is made of strong wire or wood, fastened securely where the ends are joined, then covered with roses, as shown below. The spaces *not* covered with roses are about *two* inches, and are left that the wreath may be held in the hand without crushing the roses; these spaces should be neatly wrapped with pink ribbon and finished off with a bow and streamers. The roses should be made of tissue-paper.

The class should be arranged according to size, with smallest in front; beginning with No. 1, every other one should enter from left rear, the others from right rear. Nos. 1 and 2, meeting at A, march down the centre to the front, and No. 1 line turns to the left, No. 2 to the right, each pupil taking her stand according to number, which should correspond with diagram. The last five couples do not separate when marching down the centre. Impress it upon each pupil to *remember* her number throughout the drill. At a given signal lines 1 and 3, 21 and 22, 2 and 4 face each other, standing with *toes* on the line; at signal *two*, lines 2, 22, and 3 change *wreath* from *right* to *left* hand; at signal *three*, lines 1, 21, and 4 extend wreath to partners, who take hold of the wreath with *right* hand; at the same time all should place the right toe on dotted line so as to touch the toe of partner. Arms extended

should be *perfectly straight*, which necessitates the body to bend backward slightly, with left knee bent, while right is straight. By *practice* all of these positions can be quickly taken. The musician should here begin to play some *slow* march or waltz.)

Position 1.—The wreaths, which are perpendicular to the floor, should be turned towards the front on 1, 3, back to perpendicular position on 2, 4; this is done by the couples simply twisting the arm from the elbow down. On 5, *all* step back to places, with arms at the side, and remain so on 6.



Position 2.—On 7, the lines 2, 22, and 3 extend their wreaths, or left arm to partner, who also extends her left arm and takes hold of wreath; left toes touching on dotted line; position of body and knees the same as above except *right* is bent, and *left* is straight; remain in this position on 8. On 1 and 3 twist wreaths towards the rear: back to per-

pendicular position 2, 4; on 5, 6, all step back to places with arms at the side; as they step back, lines 2, 22, and 3 again change their wreaths to right hand, as they were in marching.

Position 3.—On 7, 8, all extend *both* arms and take hold of partner's wreath, at the same time putting *right* toes on dotted line, as directed in Pos. 1. Twist the wreaths inward on 1, 3, back in perpendicular position on 2, 4. On 5, 6, all back to places, standing as before directed.

Position 4.—On 7, 8, all extend arms as in Pos. 3; *left* toes on the dotted line. Twist wreaths inward again. On 5, 6, lines 1, 21, and 4 bring *right* feet up to left, with toes touching dotted line; lines 3, 22, and 2 bring left foot *back* to right; all still having hold of wreaths.

Position 5.—On 7, 8, all should throw the arms towards the front over their heads, bringing the couples back to back, with wreaths on shoulders.

On 1, 3, 5, 7, thrust both arms straight down at the side; back to shoulder on 2, 4, 6, 8.

Position 6.—On 1, 3, 5, 7 thrust arms straight out at side; back to shoulder on 2, 4, 6, 8.

Position 7.—On 1, 3, 5, 7 thrust arms up, back on 2, 4, 6, 8.

Position 8.—Same as directed in Pos. 7.

Position 9.—With wreath still on shoulder, arms down at the side on 1, on shoulder at 2, out at the side on 3, back to shoulder on 4, up on 5, shoulder on 6, out at the side on 7, shoulder on 8. Repeat.

Position 10.—On the last 8, drop arms at the side instead of on shoulder; keep arms at the side during the following 16 counts. On 1, 3, *all* put the *right* foot diagonally forward, back on 2, 4; same with *left* foot on 5, 6 and 7, 8. Alternate right, left, etc., through 8 count; right foot out on 1 and 5, back on 2 and 6; left foot out on 3 and 7, back on 4 and 8.

Position 11.—With backs still together, the couples step to the side (or front of stage) on 1, 3, 5, 7, back on 2, 4, 6, 8; lines 1, 21, and 4 using the *right* foot,

and lines 3, 22, 2, using the *left*. Same movement with other foot to the other side (rear of stage) through 8 counts. As the step is taken toward the side each time, the *arm* corresponding to the foot used should be thrust upward on 1, 3, 5, 7, back to side on 2, 4, 6, 8.

Position 12.—On 1, of next measure, arms toward rear of stage should be thrown over heads; and every one, holding wreath in *right* hand, should step back to position as at the beginning of the drill.

MARCH.

At a given signal, lines 1 and 3, 21 and 22, 4 and 2, raise their right arms so as to form an arch, by having the wreaths touch. Stand a few seconds in this position, as the three arches are very effective.

At signal 2, Nos. 21 and 22 drop right arms at the side and march to the rear of stage *under* the *centre* arch; the leaders are followed by 23 and 24, etc.; at A the lines separate, No. 21 turning to the right and marching to front of stage under the right-hand arch; No. 22, turning to left, marches to front of stage under left-hand arch. As Nos. 21 and 22 meet at B, they form an arch, under which 23 and 24 pass and form an arch; each couple as it passes under the last arch forms another until the centre arch is complete. When the three arches are formed again, Nos. 1 and 3 and 2 and 4 drop their right arms at the side, and Nos. 1 and 2 lead their lines to rear of stage under their respective arches. No. 1 is followed by 3; 3 by 5; 5 by 7, etc. No. 2 is followed by 4; 4 by 6; 6 by 8, etc. Nos. 1 and 2 meet at A and march with their lines side by side down to front under centre arch; at B the lines separate, No. 1 going to the left and No. 2 to the right. Instead of stopping at their places, Nos. 1 and 2 lead their lines off the stage. As the last couple, 19 and 20, turn to the left and right, *all* in the centre arch drop their arms at the side, face the front and follow 21 and 22, who fall in place behind 19 and 20.

Recitations.

THE RAIN.

By Nellie M. Brown.

(During this recitation a soft accompaniment could be played upon the piano. Warren's "Brook" would be an appropriate selection.)

Tinkle, tinkle, tinkle, tinkle,
  Little drops of rain,
Leaving your wet traces
  On our window-pane,
Making tiny rivulets
  All adown our street,
Weaving mimic waterfalls
  Where these brooklets meet,
Wafting little chips and straws,
  Like fairy boats along,
Till your bright and merry ripple
  Cheers us like a song.
Tinkle, tinkle, tinkle, tinkle,
  Little drops of rain,
We are glad to see your traces
  On our window-pane.

Patter, patter, patter, patter,
  Gentle April showers;
You are bringing back to us
  The bright and gladsome flowers.
Bright-eyed yellow dandelions
  In the fields are seen,
And the modest violet hides
  Amid its leaves so green.
Crocuses and daffodils
  Lift their happy heads,
While all around a fragrance sweet
  The dainty May-flower sheds.
Aye, tender thoughts come back to us
  With the springtide flowers;
Then patter, patter, patter, patter,
  Friendly April showers.

Mutter, mutter, mutter, mutter,
  Loud the thunders roar ;
Fierce the lurid lightnings flash,
  How the torrents pour !
Sway the mighty forest trees
  'Neath the tempest's blast,
And we shrink, in frightened silence,
  Till the storm is past.
Now 'tis over : quick the dark clouds
  Westward hurrying fly.
See ! there gleams God's prismic
  Promise-token in the sky.
Smile, ye happy flowers ; ye birds,
  Your pæans chirp again,
And welcome to our parchèd earth
  The fresh'ning summer rain.

ARBUTUS.

By Lettie Sterling.

(The pupil who recites the following may hold some of the arbutus in her hands.)

Where jagged juts of rock divide
And growing room for brush provide,
In blushing prettiness abide
  Some posies sweet.
When last year's leaves are pushed aside,
  Glad eyes they greet.

These gems of early spring-time days
Call us to stony mountain ways.
We climb and search until we gaze
  On where they dwell,
Then gather them, their fragrance praise,
  And love them well.

Arbutus blossoms toil repay,
They add a pleasure to the day,
While lessons round their birthplace stay.
  Such sweet, pure light,
Cheering what hinders every ray,
  Makes truth look bright.

For if we climbed life's roughest hills
And searched with earnest, hearty wills
In haunts and spots that squalor fills,
  We'd find amid
The ignorance and briery ills
  Some sweetness hid.

And bits of hidden loveliness,
That do earth's scanty places bless,
Bid us with touching tenderness
  Be glad to know
'Neath struggles, failures, and distress
  Hope buds may grow.

PUSSY WILLOW.

(These verses should be accompanied by gestures somewhat as follows:
1. A look and gesture as toward a high bough swaying near.
2. An undulating sweep of the hand toward the south. Eyes follow gesture.
3. A sweep of the right hand, as over fields in front of the speaker. Eyes following.
4. The right hand changes its gesture to a gentle beckoning. A slight motion of the head naturally accompanies this gesture. The face and voice should be coaxing.)

The brook is brimmed with melting snow,
  The maple-sap is running,
And on the highest elm a crow (1)
  His coal-black wings is sunning.
A close green bud the May-flower lies
  Upon its mossy pillow;
And sweet and low the south-wind blows, (2)
And through the brown fields calling goes, (3)
  "Come, Pussy! Pussy Willow! (4)
Within your close brown wrapper stir;
Come out and show your silver fur.
  Come, Pussy! Pussy Willow!"

Soon red will bud the maple-trees,
  The bluebirds will be singing,
And yellow tassels in the breeze
  Be from the poplars swinging;
And rosy will the May-flower lie
  Upon its mossy pillow;
But you must come the first of all,—
"Come, Pussy!" is the south-wind's call,—(4)

"Come, Pussy! Pussy Willow!"
A fairy gift to children dear,
The downy firstling of the year,—
"Come, Pussy! Pussy Willow!" (4)

SPRING.

(From Lowell's "The Vision of Sir Launfal." Other portions could be added and used for high-school recitations.)

No price is set on the lavish summer;
June may be had by the poorest comer.
And what is so rare as a day in June?
Then, if ever, come perfect days;
Then Heaven tries the earth if it be in tune,
And over it softly her warm ear lays;
Whether we look, or whether we listen,
We hear life murmur, or see it glisten;
Every clod feels a stir of might.
An instinct within it that reaches and towers,
And, groping blindly above it for light,
Climbs to a soul in grass and flowers;
The flush of life may well be seen
Thrilling back over hills and valleys;
The cowslip startles in meadows green,
The buttercup catches the sun in its chalice,
And there's never a leaf nor blade too mean
To be some happy creature's palace;
The little bird sits at his door in the sun,
Atilt like a blossom among the leaves,
And lets his illumined being o'errun
With the deluge of summer it receives;
His mate feels the eggs beneath her wings,
And the heart in her dumb breast flutters and sings;
He sings to the wide world, and she to her nest.

THE SECRET.

(This recitation, for an intermediate pupil, must be spoken brightly and in a conversational manner.)

We have a secret, just we three,
The robin, and I, and the sweet cherry-tree;
The bird told the tree, and the tree told me,
And nobody knows it but just us three.

But of course the robin knows it best,
Because he built the—I sha'n't tell the rest;
And laid the four little—somethings in it—
I am afraid I shall tell it every minute.

But if the tree and the robin don't peep,
I'll try my best the secret to keep;
Though I know when the little birds fly about,
Then the whole secret will be out.

THE OAK.

(Recitation for a boy.)

A glorious tree is the old gray oak;
He has stood for a thousand years—
Has stood and frowned
On the trees around,
Like a king among his peers.
As around their king they stand, so now,
When the flowers their pale leaves fold,
The tall trees round him stand, arrayed
In their robes of purple and gold.
He has stood like a tower
Through sun and shower,
And dared the winds to battle;
He has heard the hail,
As from plates of mail,
From his own limbs shaken, rattle;
He has tossed them about, and shorn the tops
(When the storm has roused his might)
Of the forest trees, as a strong man doth
The heads of his foes in fight.

—*George Hill.*

WOODMAN, SPARE THAT TREE.

(In assigning this poem for a recitation, the history of its inspiration could be briefly given as follows, in the author's own words:)

Riding out of town a few days since, in company with a friend, an old gentleman, he invited me to turn down a little, romantic woodland pass, not far from Bloomingdale. "Your object?" inquired I. "Merely to look once more at an old tree planted by my grandfather long before I was born, under which I used to play when a boy, and where my sisters played with me. There I often listened to the good advice of my parents. Father, mother, sisters—all are gone; nothing but the old tree remains." And a paleness overspread his fine countenance, and tears came to his eyes. After a mo-

ment's pause, he added: "Don't think me foolish. I don't know how it is: I never ride out but I turn down this lane to look at that old tree. I have a thousand recollections about it, and I always greet it as a familiar and well-remembered friend." These words were scarcely uttered when the old gentleman cried out, "There it is." Near the tree stood a man with his coat off, sharpening an axe. "You're not going to cut that tree down, surely?" Yes, but I am, though," said the woodman. "What for?" inquired the old gentleman, with choked emotion, "What for? I like that! Well, I will tell you: I want the tree for firewood." "What is the tree worth to you for firewood?" "Why, when down, about ten dollars." "Suppose I should give you that sum," said the old gentleman, "would you let it stand?" "Yes." "You are sure of that?" "Positive!" "Then give me a bond to that effect." We went into the little cottage in which my companion was born, but which is now occupied by the woodman. I drew up the bond. It was signed, and the money paid over. As we left, the young girl, the daughter of the woodman, assured us that while she lived the tree should not be cut. These circumstances made a strong impression on my mind, and furnished me with the materials for the ~~song~~ I send you.

Woodman, spare that tree!
  Touch not a single bough!
In youth it sheltered me,
  And I'll protect it now.
'T was my forefather's hand
  That placed it near his cot:
There, woodman, let it stand;
  Thy axe shall harm it not!

That old familiar tree,
  Whose glory and renown
Are spread o'er land and sea,—
  And wouldst thou hack it down?
Woodman, forbear thy stroke!
  Cut not its earth-bound ties;
Oh, spare that aged oak,
  Now towering to the skies!

When but an idle boy
  I sought its grateful shade;
In all their gushing joy,
  Here, too, my sisters played.
My mother kissed me here;
  My father pressed my hand—
Forgive the foolish tear;
  But let that old oak stand.

My heart-strings round thee cling,
  Close as thy bark, old friend;
Here shall the wild-bird sing,
  And still thy branches bend.

Old tree! the storm still brave.
  And, woodman, leave the spot;
While I've a hand to save,
  Thy axe shall harm it not.

—*George P. Morris.*

FORWARD, MARCH!

(If desirable to include more than one speaker in this poem, eight boys could be chosen, and each repeat one verse; or four boys be selected to give each two verses.)

Spring gives the order, "Forward, march!"
  'Tis borne along the eager line;
Breathes through the boughs of rustling larch,
  And murmurs in the pine.

"March!" At the sound, impatient, springs
  The mountain rill, with rippling glee,
And rolling through the valley, brings
  Its tribute to the sea.

"March!" and upon each sunny hill
  Old winter's allies, ice and snow,
Start at the music of the rill,
  And join its onward flow.

"March!" Down among the fibrous roots
  Of oaks we hear the summons ring;
The long chilled life-blood upward shoots
  To hail the coming spring.

"March!" and along each narrow neck,
  Across the plain, and up the steep,
The spring-tide clears the winter's wreck
  With its resistless sweep.

Advancing in unbroken lines,
  New allies rush to join its band,
Till winter, in despair, resigns
  The sceptre to its hands.

Flora unfolds her banner bright
  Above the field of flashing green,
And crocus blooms, in lines of light,
  Throw back the sunlight's sheen.

The birds in every budding tree
  Take up anew the old refrain :
The spring has come ; rejoice, all ye
  Who breathes it air again !

THE IVY GREEN.

(To be used before or after the planting of ivy. The slip could be dedicated to Charles Dickens and a short notice of his life read.)

Oh, a dainty plant is the ivy green,
  That creepeth o'er ruins old !
Of right choice food are his meals, I ween,
  In his cell so lone and cold.
The walls must be crumbled, the stones decayed,
  To pleasure his dainty whim ;
And the mold'ring dust that years have made
  Is a merry meal for him.
    Creeping where no life is seen,
    A rare old plant is the ivy green.

Fast he stealeth on, though he wears no wings,
  And a stanch old heart has he !
How closely he twineth, how tightly he clings,
  To his friend, the huge oak tree !
And slyly he traileth along the ground,
  And his leaves he gently waves,
And he joyously twines and hugs around
  The rich mould of dead men's graves.
    Creeping where no life is seen,
    A rare old plant is the ivy green.

Whole ages have fled, and their works decayed,
  And nations scattered been ;
But the stout old ivy shall never fade
  From its hale and hearty green.
The brave old plant in its lonely days
  Shall fatten upon the past ;
For the stateliest building man can raise
  Is the ivy's food at last.
    Creeping where no life is seen,
    A rare old plant is the ivy green.

—*Charles Dickens.*

THE BLUEBIRD'S SONG.

(A girl in the intermediate should be selected to recite the following.)

I know the song that the bluebird is singing,
Out in the apple-tree where he is swinging.
Brave little fellow! the skies may be dreary—
Nothing cares he while his heart is so cheery!

Hark! how the music leaps out from his throat!
Hark! was there ever so merry a note?
Listen awhile, and you'll hear what he's saying,
Up in the apple-tree swinging and swaying.

"Dear little blossoms down under the snow,
You must be weary of winter, I know.
Hark while I sing you a message of cheer:
Summer is coming, and spring-time is here!"

"Little white snowdrop! I pray you arise;
Bright yellow crocus! come, open your eyes;
Sweet little violets, hid from the cold,
Put on your mantles of purple and gold;
Daffodils! daffodils! say, do you hear?
Summer is coming, and spring-time is here!"

HOW TO MAKE A WHISTLE.

(A boy in the primary could exhibit the whistle as he tells how he makes it. At the word "blow" in the last verse, he raises it to his lips and tries it.)

First take a willow bough,
  Smooth, and round, and dark,
And cut a little ring
  Just through the outside bark.

Then tap and rap it gently
  With many a pat and pound
To loosen up the bark,
  So it may turn around.

Slip the bark off carefully,
  So that it will not break,
And cut away the inside part,
  And then a mouth-piece make.

Now put the bark all nicely back,
  And in a single minute
Just put it to your lips
  And blow the whistle in it!

WHAT DO WE PLANT?

(Recitation for a boy or girl in the grammar grade.)

What do we plant when we plant the tree?
We plant the ship, which will cross the sea
We plant the mast to carry the sails;
We plant the plank to withstand the gales.
The keel, the keelson, and beam and knee;
We plant the ship when we plant the tree.

What do we plant when we plant the tree?
We plant the houses for you and me;
We plant the rafters, the shingles, the floors;
We plant the studding, the lath, the doors,
The beams and siding, all parts that be;
We plant the house when we plant the tree.

What do we plant when we plant the tree?
A thousand things that we daily see:
We plant the spire that out-towers the crag;
We plant the staff for our country's flag;
We plant the shade, from the hot sun free—
We plant all these when we plant the tree.

—*Henry Abbey.*

ARBOR DAY IN MAY.

(This recitation has been given in some of the New York schools to open their Arbor Day celebration on May 3d. Connecticut and other Northern States will be glad to use it.)

All the buds and bees are singing;
All the lily-bells are ringing;
All the brooks run full of laughter,
And the wind comes whispering after.
What is this they sing and say?
  "It is May!
    It is our Arbor Day!
    Hurrah! hurrah for our Arbor Day!"

Look, dear children, look ! the meadows,
When the sunshine chases shadows
Are alive with fairy faces,
Peeping from ther grassy places
What is this the flowers say ?
"It is May !
It is our Arbor Day !
Hurrah ! hurrah for our Arbor Day !"

See ! the fair blue sky is brighter,
And our hearts with hope are lighter ;
All the bells of joy are ringing ;
All are grateful voices singing ;
All the storms have passed away.
"It is May !
It is our Arbor Day !
Hurrah ! hurrah for our Arbor Day !"

MAY IS HERE.

(For a high school girl to recite.)

May is here !
I know there's a blossom somewhere near,
For the south wind tosses into my room
A hint of summer—a vague perfume
It has pilfered somewhere (I cannot tell
Whether from pansy or pimpernel) ;
But it sets me dreaming of birds and bees
And the odorous snow-storms of apple-trees,
Of roses sweet by the garden-wall,
And milk-white lilies, stately and tall ;
Of clover red in the morning sun,
And withered and dead when the day is done ;
Of the song that the stalwart mower sings,
Of gladness, and beauty, and all sweet things
That summer brings.

—*Eben E. Rexford.*

THE GLADNESS OF NATURE.

(Recitation for the grammar grade.)

Is this a time to be cloudy and sad,
When our mother Nature laughs around ;
When even the deep blue heavens look glad,
And gladness breathes from the blossoming ground ?

There are notes of joy from the hang-bird and wren,
And the gossip of swallows through all the sky;
The ground-squirrel gayly chirps by his den,
And the wilding bee hums merrily by.

The clouds are at play in the azure space,
And their shadows at play on the bright green vale,
And here they stretch to the frolic chase,
And there they roll on the easy gale.

There's a dance of leaves in that aspen bower;
There's a titter of winds in that beechen tree;
There's a smile on the fruit, and a smile on the flower,
And a laugh from the brook that runs to the sea.

And look at the broad-faced sun: how he smiles
On the dewy earth that smiles in his ray;
On the leaping waters and gay young isles—
Ay, look, and he'll smile thy gloom away!

—*Bryant.*

THE PINE TREE ACADEMY.

(For six boys in the primary department to recite, each giving one verse.)

All the birdies went to school
In a pine tree, dark and cool,
At its foot a brook was flowing,
The teacher was the crow,
And what he did not know,
You may be sure was not worth knowing.

Their satchels are hanging up tidy and neat,
They smooth down their feathers and wipe off their feet,
While the wind through the tree-tops goes creeping.
"Speak up loud!" says the crow;
"I can't hear, as you know,
While the branches are swaying and creaking."

They are taught the very best way to fly,
To catch the insect that goes buzzing by;
How to cock the head when beginning to sing.
"I've a cold," says the crow,
"Or else I would show
How the nightingale does when she makes the woods ring."

The books are made of maple leaves,
For paper, bark from white-birch trees,
And for pencil each uses a stick.
"When you write," says the crow,
"Be both careful and slow;
Make your letters look graceful, not thick."

Every birdie builds a nest
In the place each thinks the best,
While the teacher gives good sound advice.
"All the stocks," says the crow,
"You must lay in a row.
Before using one, look at it twice."

All at once, with a cold blast
The rain comes falling thick and fast,
While the old pine-tree groans in the gale.
"School is closed," says the crow;"
"You must all quickly go,
But to-morrow, come back without fail."

V. E. Scharff.

(Other recitations will be found among the special exercises and quotations.)

SPRING IS COMING.

(Recitation for a primary pupil.)

I am coming, little maiden!
With the pleasant sunshine laden,
With the honey for the bee,
With the blossom for the tree,
With the flower and with the leaf—
Till I come, the time is brief.

I am coming, I am coming!
Hark! the little bee is humming;
See! the lark is soaring high
In the bright and sunny sky;
And the gnats are on the wing,
Wheeling round in airy ring.

See! the yellow catkins cover
All the slender willows over;
And on banks of mossy green
Starlike primroses are seen;

And, their clustering leaves below,
White and purple violets blow.

Hark! the new-born lambs are bleating,
And the cawing rooks are meeting
In the elms—a noisy crowd!
All the birds are singing loud;
And the first white butterfly
In the sunshine dances by.

—*Mary Howitt.*

DAFFODILS.

(Recitation for a pupil in the high school.)

I wandered lonely as a cloud
  That floats on high o'er vales and hills,
When all at once I saw a crowd—
  A host of golden daffodils—
    Beside the lake, beneath the trees,
    Fluttering and dancing in the breeze.

Continuous as the stars that shine
  And twinkle on the milky-way,
They stretched in never-ending line
  Along the margin of a bay:
    Ten thousand saw I at a glance,
    Tossing their heads in sprightly dance.

The waves beside them danced, but they
  Outdid the sparkling waves in glee:
A poet could not but be gay
  In such a jocund company:
    I gazed, and gazed, but little thought
    What wealth the show to me had brought.

For oft, when on my couch I lie
  In vacant or in pensive mood,
They flash upon my inward eye,
  Which is the bliss of solitude;
    And then my heart with pleasure fills,
    And dances with the daffodils.

—*Wordsworth.*

THE FERN AND THE MOSS.

(Recitation for a grammar-school pupil.)

There were ferns on the mountain, and moss on the moor ;
And the ferns were the rich, and the mosses the poor.
And the glad breezes blew gayly ; from heaven it came,
And the fragrance it shed over each was the same ;
And the warm sun shone brightly, and gilded the fern,
And smiled on the lowly-born moss in its turn ;
And the cool dews of night on the mountain fern fell,
And they glistened upon the green mosses as well.
And the fern loved the mountain, the moss loved the moor,
For the ferns were the rich, and the mosses the poor.

But the keen blast blew bleakly, the sun waxed high,
And the ferns they were broken, and withered, and dry ;
And the moss on the moorland grew faded and pale,
And the fern and the moss shrank alike from the gale.
So the fern on the mountain, the moss on the moor,
Were withered and black where they flourished before.

Then the fern and the moss they grew wiser in grief,
And each turned to the other for rest and relief ;
And they planned that wherever the fern roots should grow,
There surely the moss should be sparkling below.

And the keen blasts blew bleakly, the sun waxed fierce ;
But no wind and no sun to their cool roots could pierce ;
For the fern threw her shadow the green moss upon,
Where the dew ever sparkled undried by the sun ;
When the graceful fern trembled before the keen blast,
The moss guarded her roots till the storm-wind had passed ;

So no longer the wind parched the roots of the one,
And the other was safe from the rays of the sun.

And thus, and forever, where'er the ferns grow,
There surely the mosses lie sparkling below;
And thus they both flourish, where naught grew before,
And they both decked the woodland and mountain and moor.

—*Eliza Cook.*

TREES.

(The following may be given entire as a reading or recitation or used in fragments and recited by different pupils in turn.)

First in our regard, as it is first in the whole nobility of trees, stands the white elm, no less esteemed because it is an American tree, known abroad only by importation, and never seen in all its magnificence except in our own valleys. The old oaks of England are very excellent in their way, gnarled and rugged. The elm has strength as significant as they, and a grace, a royalty, which leaves the oak like a boor in comparison. Had the elm been an English tree, and had Chaucer seen and loved and sung it; had Shakespeare and every English poet hung some garlands upon it, it would have lifted up its head now, not only the noblest of all growing things, but enshrined in a thousand rich associations of history and literature.

To the great tree-loving fraternity we belong. We love trees with universal and unfeigned love, and all things that do grow under them or around them—the whole leaf and root tribe. Not alone when they are in their glory, but in whatever state they are—in leaf, or rimed with frost, or powdered with snow, or crystal-sheathed in ice, or in severe outline stripped and bare against a November sky—we love them. Our heart warms at the sight of even a board or a log. A lumber-yard is better than nothing. The *smell* of wood, at least, is there, the savory fragrance of resin, as sweet as myrrh and

frankincense ever was to a Jew. If we can get nothing better, we love to read over the names of trees in a catalogue. Many an hour have we sat at night, when, after exciting work, we needed to be quieted, and read nursery-men's catalogues, and Loudon's Encyclopædias and Arboretum, until the smell of the woods exhaled from the page, and the sound of leaves was in our ears, and sylvan glades opened to our eyes that would have made old Chaucer laugh and indite a rapturous rush of lines.

Different species of trees move their leaves very differently, so that one may sometimes tell by the motion of shadows on the ground, if he be too indolent to look up, under what kind of tree he is dozing. On the tulip-tree (which has the finest name that ever tree had, making the very pronouncing of its name almost like the utterance of a strain of music —*Liriodendron tulipifera*)—on the tulip-tree, the aspen, and on all native poplars, the leaves are apparently Anglo-Saxon or Germanic, having an intense individualism. Each one moves to suit itself. Under the same wind one is trilling up and down, another is whirling, another slowly vibrating right and left, and others still quieting themselves to sleep, as a mother gently pats her slumbering child; and each one intent upon a motion of its own. Sometimes other trees have single frisky leaves, but usually the oaks, maples, beeches, have community of motion. They are all acting together, or all are alike still.

—*Henry Ward Beecher.*

THE DROOPING-WILLOW.

(These verses may be used for a recitation descriptive of the weeping-willow of our country. This tree is looked upon as a symbol of sorrow, not alone for the mournful droop of the branches but because of the drops of water that often remain a long time upon the hanging leaves.)

Green willow! over whom the perilous blast
Is sweeping roughly, thou dost seem to me
The patient emblem of humility,

Waiting in meekness till the storm be passed,
Assured an hour of peace will come at last;
That there will be for thee a calm bright day
When the dark clouds are gathered far away.

How canst thou ever sorrow's emblems be?
Rather I deem thy slight and fragile form,
In mild endurance bending gracefully,
Is like the wounded heart, which 'mid the storm
Looks for the promised time which is to be,
In pious confidence. Oh, thou shouldst wave
Thy branches o'er the lowly martyr's grave!

—*L. E. Landon.*

THE WAYSIDE INN.

(Recitation for a pupil in the grammar grade.)

I halted at a pleasant inn,
  As I my way was wending—
A golden apple was the sign,
  From knotty bough depending.

Mine host—it was an apple-tree—
  He smilingly received me,
And spread his sweetest, choicest fruit
  To strengthen and relieve me.

Full many a little feathered guest
  Came through his branches springing;
They hopped and flew from spray to spray,
  Their notes of gladness singing.

Beneath his shade I laid me down,
  And slumber sweet possessed me;
The soft wind blowing through the leaves
  With whispers low caressed me.

And when I rose and would have paid
  My host so open-hearted,
He only shook his lofty head—
  I blessed him and departed.

—*From the German.*

LONGING.

(A recitation for a high-school pupil. Each line must be spoken deliberately, each word distinctly.)

I must away to wooded hills and vales,
  Where broad, slow streams flow cool and silently,
And idle barges flap their listless sails.
For me the summer sunset glows and pales,
  And green fields wait for me.

I long for shadowy forests, where the birds
  Twitter and chirp at noon from every tree;
I long for blossomed leaves and lowing herds;
And Nature's voices say in mystic woods,
  "The green fields wait for thee."

I dream of uplands, where the primrose shines
  And waves her yellow lamps above the lea;
Of tangled copses, swung with trailing vines;
Of open vistas, skirted with tall pines,
  Where green fields wait for me.

I think of long, sweet afternoons, when I
  May lie and listen to the distant sea,
Or hear the breezes in the reeds that sigh,
Or insect voices chirping shrill and dry,
  In fields that wait for me.

These dreams of summer come to bid me find
  The forest's shade, the wild bird's melody,
While summer's rosy wreaths for me are twined,
While summer's fragrance lingers on the wind,
  And green fields wait for me.

—*George Arnold.*

THE VERNAL SHOWER.

(To be recited by a girl in the grammar department.)

Now the lucid tears of May
Gem the blossoms of the spray;
Every leaf and bending flower
Glitters in the vernal shower.

Lovely in the clouded sky
See, the Rainbow shines on high;
Mark the heavenly colors bright
Ere they vanish from the sight.

Fairer now the view around ;
Brighter verdure decks the ground ;
Flora, smiling in her bower,
Hails the tender vernal shower.

Cool and fragrant is the gale,
Breathing sweets from yonder vale ;
Where the flowers in freshened pride
Smile upon the fountain side.

See ! again the skies appear
Clad in blue, serenely clear :
Mild and genial is the hour ;
Sweet the balmy vernal shower.

—*Mrs. Hemans.*

THE FRINGED GENTIAN.

(In several of the States Arbor Day is celebrated in October or November. In these months the following verses may be appropriately introduced into the programme.)

Thou blossom, bright with autumn dew,
  And colored with the heaven's own blue,
That openest when the quiet light
  Succeeds the keen and frosty night;

Thou comest not when violets lean
  O'er wandering brooks and springs unseen,
Or columbines, in purple dressed,
  Nod o'er the ground-bird's hidden nest.

Then doth thy sweet and quiet eye
  Look through its fringes to the sky,
Blue—blue—as if that sky let fall
  A flower from its cerulean wall.

Thou waitest late, and com'st alone,
  When woods are bare and birds have flown,
And frosts and shortening days portend
  The aged year is near his end.

I would that thus, when I shall see
  The hour of death draw near to me,
Hope, blossoming within my heart,
  May look to heaven as I depart.

—*Bryant.*

Songs.

PLANT THE TREES, CHILDREN

By Rev. Dr. C. S. Percival.

(Air : "Ring the Bell, Watchman." Substitute the name of another State in the chorus in place of "Iowa," according to the locality.)

Round the green playground the dear children stand,
Joy in their faces and shovel in hand,
Waiting a word to be borne on the breeze—
Ready for the welcome mandate : "Plant, plant the trees."

Chorus :

Plant the trees, children, plant, yes plant ;
Plant for a joy that the future will grant.
Iowa sends forth her word on the breeze—
Joyfully obey the summons : "Plant, plant the trees."

When you are old you may bask in the shade
Which by the growth of this planting is made.
Your children's children, so Heaven decrees,
Will rejoice you heard the summons : "Plant, plant the trees."

Chorus.—Plant the trees, etc.

Plant trees of knowledge where ignorance reigns ;
Plant trees of virtue on sin's arid plains ;
Make of yourselves "trees of righteousness ;"—these
Plantings fill the world with beauty : "Plant, plant the trees."

Chorus.—Plant the trees, etc.

When, having passed to the happier land,
Fast by the "Tree of Life" joyful you stand,
Gladly you'll learn how the Saviour decrees
Earthly planting blooms in glory : "Plant, plant the trees."

Chorus.—Plant the trees, etc.

WE HAVE COME.

(Sing this to "Hark, the Herald Angels Sing," repeating the last line of each verse.)

We have come with joyful greeting,
  Songs of gladness, voices gay,
Teachers, friends, and happy children,
  All to welcome Arbor Day.
Here we plant the tree whose branches,
  Warmed by breath of summer days,
Nourished by soft dews and showers,
  Soon shall wave in leafy spray.

Gentle winds will murmur softly,
  Zephyrs float on noiseless wing;
'Mid its boughs shall thrush and robin
  Build their nests and sweetly sing.
'Neath its sheltering arms shall childhood,
  Weary of the noontide heat,
In its cool, inviting shadow
  Find a pleasant, safe retreat.

Plant we then, throughout our borders,
  O'er our lands so fair and wide,
Treasures from the leafy forest,
  Vale and hill and mountain-side.
Rooted deep, oh, let them flourish;
  Sturdy giants may they be!
Emblems of the cause we cherish—
  Education broad and free!

—*Sarah J. Pettinos.*

MERRY SPRING.

(To be sung by the primary children to "Lightly Row.")

Merry spring,
Will you bring
Back the little birds to sing?
I am sad;
Make me glad,
Gentle, merry, laughing spring.

Winter's snow
Had to go
From the hills and vales below;
Then the showers
Made the flowers
Over all the hillsides grow.

Mother said,
"They're not dead—
Only sleeping in their bed;
When spring rain
Comes again,
Each one lifts its tiny head."

O HAPPY DAY!

(These words are suited to the familiar air, "The Soldier's Farewell." If sung in parts the effect will be very beautiful.)

O happy day returning,
For thee our hearts are yearning!
We come with joyous greeting,
Old friends and schoolmates meeting,
O Arbor Day, dear Arbor Day,
To sing thy praise, sweet Arbor Day!

Blest be the trees we've planted,
Blest be the songs we've chanted;
May other lives be brighter,
And other hearts be lighter,
O Arbor Day, dear Arbor Day,
To sing thy praise, sweet Arbor Day!

Live trees and bloom fair roses!
And as each spring discloses
To younger hearts your beauty,
May they do loving duty,
O Arbor Day, dear Arbor Day,
To sing thy praise, sweet Arbor Day!

Blest be the day we cherish,
Its mem'ry never perish,
And with each spring returning,
May other lips be learning,
O Arbor Day, dear Arbor Day,
To sing thy praise, sweet Arbor Day!

—*Lewis Halsey.*

FIFTY QUOTATIONS.

He who plants a tree
Plants a hope.
Rootlets up through fibres blindly grope;
Leaves unfold into horizons free.
So man's life must climb
From the clods of time
Unto heavens sublime.
Canst thou prophesy, thou little tree,
What the glory of thy boughs shall be?
—*Lucy Larcom.*

Spring-time is coming! search for the flowers!
Brush off the brown leaves, the darlings are here!
Joy of the spring-hours, picking the May flowers!
Kiss the spring beauties, the babes of the year.

I remember, I remember
The fir-tree dark and high;
I used to think their slender tops
Were close against the sky.
—*Thomas Hood.*

A light little zephyr came flitting,
Just breaking the morning repose.
The rose made a bow to the lily,
The lily she bowed to the rose.

And then, in a soft little whisper,
As faint as a perfume that blows,
"You are brighter than I," said the lily;
"You are fairer than I," said the rose.
—*St. Nicholas.*

The birds are hushed; alone the wind,
That through the woodland searches,
The red oak's lingering leaves can find,
And yellow plumes of birches.

But still the balsam-breathing pine
Invites no thought of sorrow.
No hint of loss from air like wine
The earth's content can borrow.
—*Whittier.*

I love thee in the spring,
Earth-crowning forest! when amid the shades
The gentle south first waves her odorous wing,
And joy fills all the glades.

In the hot summer time,
With deep delight, the sombre aisle I roam,
Or, soothed by some cool brook's melodious chime,
Rest on thy verdant loam.

But oh, when autumn's hand
Hath marked thy beauteous foliage for the grave,
How doth thy splendor, as entranced I stand,
My willing heart enslave!

Would, then, my noble master please
To grant my highest wishes,
He'll shade my banks wi' towering trees
And bonnie spreading bushes.

Let lofty firs and ashes cool
My lowly banks o'erspread,
And view, deep bending in the pool,
Their shadows' wat'ry bed.

Let fragrant birds, in woodbines drest,
My craggy cliffs adorn;
And, for the little songsters' nest,
The close embow'ring thorn.

Our forests are fast disappearing. In their sheltering shade, and the rich mould of their annually decaying leaves, the greater number of our loveliest plants are found. As the woods are cleared away, these tender offsprings, the pretty flowers, which we so dearly cherish, will perish utterly. It is, therefore, well to prevent, as far as possible, the destruction of our native forests, as well as to plant forest trees, if for no other purpose than the preservation of the little, helpless, blooming beauties that adorn our woodland shades.

From the earth's loosened mould,
The sapling draws its sustenance and thrives;
Though stricken to the heart with winter's cold
The drooping tree revives.

The softly warbled song,
Comes from the pleasant woods, and colored wings
Glance quick in the bright sun that moves along
The forest openings.

The willow is almost the earliest to gladden us with the promise and reality of beauty in its graceful and delicate foliage, and the last to scatter its yellow yet scarcely withered leaves upon the ground. All through the winter, too, its yellow twigs give it a seeming aspect, which is not without a cheering influence, even in the grayest and gloomiest day. Beneath a clouded sky it faithfully remembers the sunshine.

So long as the rivers flow,
So long as the mountains rise
And shelter the earth below,
May the forest sing to the skies.

— *Venable.*

Their honored leaves the green oaks reared,
And crowned the upland's graceful swell ;
While answering through the vale was heard
Each distant heifer's tinkling bell.

Hail, greenwood shades, that, stretching far,
Defy e'en summer's noontide power,
When August in his burning car
Withholds the clouds, withholds the shower.

—*Robert Bloomfield, writing of Whittlebury Forest.*

Almond blossoms, sent to teach us
That the spring days soon will reach us,
Lest, with longing overtried,
We die as the violets died,—
Blossoms clouding all the tree
With thy crimson broidery,
Long before a leaf of green
On the bravest bough is seen,—
Ah ! when winter winds are swinging
All thy red bells into singing,
With a bee in every bell,
Almond bloom, we greet thee well.

—*Edwin Arnold.*

What monuments the trees, the monarchs of the vegetable world, become! They are more durable than marble itself. Their grandeur will challenge the admiration of the beholder when the coeval marble monument at their base will lie in ruins, defaced by age and crumbling into dust.

—*John B. Peaslee.*

Oh, you pussy-willow! pretty little thing,
Coming with the sunshine of the early spring!—
Tell me, tell me, pussy, for I want to know,
Where it is you come from, how it is you grow?

Plant trees and care for them. They will repay you for many years to come in fruit and nuts and flowers; and will afford protection for man, beast, and bird against the piercing rays of old Sol in summer, and the fierce blasts of rude Boreas in winter.

—*Larrabee.*

All ye woods, and trees, and bow'rs,
All ye virtues and ye pow'rs
That inhabit in the lakes,
In the pleasant springs or brakes,
Move your feet
To our sound,
Whilst we greet
On this ground.

Under the greenwood tree
Who loves to lie with me,
And tune his merry note
Unto the sweet bird's throat,
Come hither, come hither, come hither;
Here shall ye see
No enemy,
But winter and rough weather.

—*Shakespeare.*

This is the forest primeval. The murmuring pines and the hemlocks,
Bearded with moss, and in garments green, indistinct in the twilight,

Stand like Druids of old, and with voices sad and prophetic,
Stand like harpers hoar, with beards that rest on their bosoms.
Loud from its rocky caverns the deep-voiced neighboring ocean
Speaks, and in accents disconsolate answers the wail of the forest. —*Longfellow.*

Summer or winter, day or night,
The woods are an ever new delight;
They give us peace, and they make us strong,
Such wonderful balms to them belong;
So, living or dying, I'll take my ease
Under the trees, under the trees. —*Stoddard.*

I'd rather be a daisy,
The little children's flower,
Than any prouder beauty
That decks my lady's bower.
—*Glover.*

Welcome, maids of honor!
Ye do bring
In the spring
And wait upon her.
—*Herrick*, "*To Violets.*"

What plant we in this apple-tree?
Sweets for a hundred flowery springs
To load the May wind's restless wings,
When from the orchard row he pours
Its fragrance through our open doors;
A world of blossoms for the bee,
Flowers for the sick girl's silent room,
For the glad infant sprigs of bloom,
We plant with the apple-tree.

What plant we in this apple-tree?
Fruits that shall swell in sunny June,
And redden in the August noon,
And drop, when gentle airs come by,
That fan the blue September sky,

While children come, with cries of glee,
And seek them where the fragrant grass
Betrays their bed to those who pass
At the foot of the apple-tree. —*Bryant.*

Hurrah for the beautiful trees!
Hurrah for the forest grand!
The pride of His centuries,
The garden of God's own hand.
—*Venable.*

Like leaves on trees the race of man is found—
Now green in youth, now withering on the ground;
Another race the following spring supplies;
They fall successive, and successive rise. —*Pope.*

Sweet are the uses of adversity,
Which, like the toad, ugly and venomous,
Wears yet a precious jewel in his head;
And this our life, exempt from public haunt,
Find tongues in trees, books in the running brooks,
Sermons in stones, and good in everything.
—*Shakespeare.*

O, happy trees, which we plant to-day,
What great good-fortunes wait you!
For you will grow in sun and snow
Till fruit and flowers freight you.

Shrubs there are
That at the call of spring
Burst forth in blossomed fragrance; lilacs robed
In snow-white innocence or purple pride.
—*Thomson.*

Give fools their gold and knaves their power;
Let fortune's bubbles rise and fall;
Who sows a field, or trains a flower,
Or plants a tree, is more than all.
—*Whittier.*

These as they change, Almighty Father, these
Are but the varied God; the rolling year
Is full of Thee. Forth in the pleasing spring
Thy beauty walks, Thy tenderness and love.

Wide flush the fields; the softening air is balm;
Echo the mountains round; the forest smiles;
And every sense, and every heart is joy.
Then comes Thy glory in the summer months,
With light and heat refulgent. Then thy sun
Shoots full perfection through the swelling year;
And oft thy voice in dreadful thunder speaks,
And oft at dawn, deep noon, or falling eve,
By brooks and groves in hollow whispering gales,
Thy beauty shines in autumn unconfined,
And spreads a common feast for all that lives.

—*Thomson.*

Dull Winter hastens to be gone:
He's disappearing fast;
The sunny hours are coming on,
The stormy time is past.
The ice no longer binds the rill.
Nor snows their mantle fling;
For every bleak and barren hill
Has kissed the breeze of spring.

—*R. Townley.*

Every season, in the country, has its dominant musical note; and of the month of March, in Portugal, this note is the wryneck's cry. It comes with a sudden, quite startling music of its own from the still leafless coppice, to tell that the time of bud and leaf and flower is at hand. The sound, too, has a certain mystery about it; for though the notes are everywhere in the air, and every dweller here knows them well and welcomes them, the bird that utters them is very seldom seen. Our first spring visitors are the bluebird and the robin, the bluebird invariably coming first. He seems to say, "Hear me, hear me!"

I come, I come, ye have called me long.
I come o'er the mountains with light and song!
Ye may trace my step o'er the wakening earth,
By the winds which tell of the violet's birth,
By the primrose-stars in the shadowy grass,
By the green leaves opening as I pass.

—*Mrs. Hemans.*

He who plants a tree,
He plants love;
Tents of coolness spreading out above
Wayfarers he may not live to see.
Gifts that grow are best;
Hands that bless are best.
Plant! Life does the rest!
Heaven and earth help him who plants a tree,
And his work its own reward shall be.

—*Lucy Larcam.*

April is called so, for it opens the flowers.
April, the opener, unlocks everything:
Gray fields, bare fallows, and these hearts of ours,—
All but the misers feel the joy of spring.

The pine is the tree of silence. Who was the Goddess of Silence? Look for her altars amid the pines—silence above, silence below. One walks over a carpet of pine needles almost as noiselessly as over the carpets of our own dwellings. Do these halls lead to the chambers of the great, that all noise should be banished from them? Let the designers come here and get the true pattern for a carpet—a soft yellowish-brown, with only a red leaf, or a bit of gray moss, or a dusky lichen scattered here and there; a background that does not weary or bewilder the eye, or insult the ground-loving foot.

—*John Burroughs.*

A song to the old oak!—the brave old oak!
Who hath ruled in the greenwood long.
Here's health and renown to his broad, green crown,
And his fifty arms so strong. —*Chorley.*

The monarch-oak, the patriarch of the trees,
Shoots slowly up, and spreads by slow degrees;
Three centuries he grows, and three he stays,
Supreme in state, and in three more decays.

—*Dryden.*

To watch over the life of the plant and its general harmony, is it not to watch over the safety of humanity? The tree was created for the nurture of man,

to assist him in his industries and his arts. It is owing to the tree, to its soul, earth-buried for so many centuries, and now restored to light, that we have secured the wings of the steam-engine.

In my plot no tulips blow—
  Snow-loving pines and oaks instead ;
And rank the savage maples grow
  From spring's faint flush to autumn red.

My garden is a forest ledge,
  Which older forests bound ;
The banks slope down to the blue lake-edge
  Then plunge to depths profound.

Oh, who will really undertake the defence of the trees, and rescue them from senseless destruction? Who will eloquently set forth their manifold mission, and their active and incessant assistance in the regulation of the laws which rule our globe? Without them it seems delivered over to blind destiny, which will involve it again in chaos.

  The heave, the wave, and bend
Of everlasting trees, whose busy leaves
Rustle their songs of praise.
  Monarchs of the wood,
Whose mighty sceptres sway the mountain broad,
Shelter the winged idolaters of day,
And grapple with the storm-god, hand to hand,
Then drop like weary pyramids away,
Stupendous monuments of calm decay.

Sweet spring is returning ;
  She breathes on the plain,
And meadows are blooming
  In beauty again.
Now fair is the flower,
  And green is the grove,
And soft is the shower
  That falls from above.

Full gladly we greet thee,
  Thou loveliest guest !
Ah, long have we waited

By thee to be blessed!
Stern Winter threw o'er us
His hoary, cold chain:
We longed to be breathing
In freedom again.

And welcome, thou loved one,
Again and again,
And bring us full many
Bright joys in thy train,
And bid the soft summer
Not linger so long.
E'en now we are waiting
To greet him in song.

When we plant a tree, we are doing what we can to make our planet a more wholesome and happier dwelling-place for those who come after us, if not for ourselves. As you drop the seed, as you plant the sapling, your left hand hardly knows what your right hand is doing. But Nature knows, and in due time the Power that sees and works in secret will reward you openly. You have been warned against hiding your talent in a napkin; but if your talent takes the form of a maple-key or an acorn, and your napkin is a shred of the apron that covers "the lap of the earth," you may hide it there, unblamed; and when you render in your account you will find that your deposit has been drawing compound interest all the time. —*O. W. Holmes.*

Trees have about them something beautiful and attractive even to the fancy. Since they cannot change their plan, they are witnesses of all the changes that take place around them; and, as some reach a great age, they become, as it were, historical monuments, and, like ourselves, they have a life, growing and passing away, not being inanimate and unvarying, like the fields and rivers. One sees them passing through various stages, and at last, step by step, approaching death, which makes them look still more like ourselves. —*Humboldt.*

A man does not plant a tree for himself. And sitting idly in the sunshine, I think at times of the unborn people who will, to some small extent, be indebted to me. Remember me kindly, ye future men and women! —*Alexander Smith.*

O! hast thou ever stood to see
The holly tree?
* * * * * *
All vain asperities I day by day
Would wear away,
'Till the smooth temper of my age should be
Like the high leaves upon the holly tree.

And as when all the summer trees are seen
So bright and green,
The holly leaves a sober hue display
Less bright than they;
But when the bare and wintry woods we see,
What, then, so cheerful as the holly tree.
So would I seem amid the young and gay
More grave than they!
That in my age as cheerful I might be
As the green winter of the holly tree.
—*Robert Southey.*

Behold the trees unnumbered rise,
Beautiful in various dyes:
The gloomy pine, the poplar blue,
The yellow beech, the sombre yew,
The slender fir that taper grows,
The sturdy oak, with broad-spread boughs.
—*Dyer.*

Verdant grove, farewell to thee,
Clad in vernal beauty;
Thine my parting song shall be,—
'Tis a sacred duty.

Let thy warbler's tuneful throng
Bear the echoes of my song
Far o'er hill and valley,
Far o'er hill and valley.

(Other selections may be made from the Special Exercises and Recitations.)

SUGGESTED PROGRAMMES.

PRIMARY—BOYS.

(" Song Treasures " and " Best Primary Songs " are published by E. L Kellogg & Co.)

1. Opening Song: " The Mower's Song." (" Best Primary Songs.")
2. Speech: " About Arbor Day." (Extracts from " How Arbor Day Started.")
3. Recitation: " The Secret."
4. Exercise for eight pupils: " Little Runaways."
5. Song for four pupils: " Which is the Wind?" (" Best Primary Songs.")
6. Recitation: " Pussy Willow."
7. Exercise for nine boys: " The Plea of the Trees."
8. March.
9. Recitation: " How to Make a Whistle."
10. Song: " Farewell to School." (" Best Primary Songs.")

(Adjourn to the tree-planting.)

PRIMARY—GIRLS.

1. Opening Song: " Merry Spring."
2. Why we celebrate Arbor Day. (Short talk by the teacher.)
3. Recitation: " The Rain."
4. Exercise for five little girls: " May."
5. Song: " The Summer Woods." (" Best Primary Songs.")
6. The Pink Rose Drill.
7. Quotations. (Five or more pupils.)
8. Recitation: " The Bluebird's Song."
9. Talk by the teacher on the meaning of Arbor Day.
10. Song: " Merry Spring."

(Adjourn to the tree-planting.)

PRIMARY—MIXED.

1. Opening Song: "To Our Friends." (Best Primary Songs.)
2. Arbor Day in Our State. (Talk by the teacher.)
3. Recitation by a girl: "The Bluebird's Song."
4. Recitation for six boys: "The Pine-tree Academy."
5. Song for the boys: "A Little More Singing." ("Song Treasures.")
6. Exercise for ten or more pupils: "November's Party."
7. Composition by a boy: "The Trees I Like."
8. Composition by a girl: "My Vacation."
9. Exercise for fifteen pupils: "The Poetry of Spring."
10. Closing song and march.

GRAMMAR—GIRLS.

1. Opening Song: "Come, Come, Come." ("Song Treasures.")
2. Reading of Governor's Proclamation of Arbor Day.
3. Essay by a pupil: "Trees of Our State."
4. Piano solo (some selection descriptive of nature).
5. Exercise for nine girls: "The Arbor Day Queen."
6. Recitation with planting of an ivy: "The Ivy Green."
7. Quotations. Ten pupils.
8. Recitation: "Arbutus."
9. Essay on "Trees and Flowers."
10. Song and march to the tree.

GRAMMAR—BOYS.

1. Opening song: "Plant the Trees."
2. Declamation (original; the subject to be, "Why we Plant Trees").
3. Recitation: "The Oak."
4. Quotations (six pupils),

5. Song: "Spring." ("Song Treasures.")
6. Recitation: "Woodman, Spare that Tree."
7. Remarks by the teacher.
8. Recitation for four or eight boys: "Forward, March."
9. Song: "Walk, Walk, Walk." ("Song Treasures.")
10. Tree-planting exercise. (In two parts.)

GRAMMAR—MIXED.

1. Exercise: "The Coming of Spring."
2. Song: "We Have Come."
3. Recitation: "What Do we Plant?"
4. Essay on "Forestry."
5. Recitation: "Arbor Day in May."
6. Quotations. Ten pupils.
7. Song: "The Voice within Us." ("Song Treasures.")
8. Talk by the teacher or superintendent.
9. Song and march.
10. Exercise: "Through the Year with the Trees."

HIGH SCHOOL—MIXED.

1. Song: "We Have Come."
2. Reading of Governor's Proclamation, and remarks upon it by a pupil.
3. Essay: Historic Trees."
4. Quotations. Ten or more pupils.
5. Recitation: "May is Here."
6. Solo on piano or other instrument.
7. Reading from "The Vision of Sir Launfal."
8. Song: "O Happy Day!"
9. Reading of letters from distinguished people concerning Arbor Day (these must be secured beforehand).
10. Closing song: "Nature's Teachings." ("Song Treasures.")